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Otology & Audiology Article Review

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- Page 18: Christina Röbke:
  - Untangling the effects of tinnitus and hypersensitivity to sound (hyperacusis) in the gap detection test.
    - *R.H. Salloum, S. Sandridge, D.J. Patton, G. Stillitano, G. Dawson, J. Niforatos, L. Santiago & J.A. Kaltenbach*
    - *Hearing Research 331 (2016) 92-100*
    - *The results of this study demonstrate that not only hearing loss but also changes in sensitivity to background noise or to startle stimuli are potential confounds that, when present, can underlie gap detection irrespective of tinnitus.*

- Page 20: Christina Röbke:
  - Cochlear implantation as a long-term treatment for ipsilateral incapacitating tinnitus in subjects with unilateral hearing loss up to 10 years.
    - *Griet Martens, Marc De Bodt & Paul Van de Heyning*
    - *Hearing Research 331 (2016) 1-6*
    - *The study aimed to do a long-term evaluation of CI in subjects suffering from UHL and accompanied by incapacitating tinnitus for up to 10 years.*

- Page 22: Reddy Sivaprasad:
  - Effects of Steady – State Noise on Verbal Working Memory in Young Adults.
    - *Nicole Marrone, Mary Alt, Gayle DeDe, Sarah Olson & James Shehorn.*
    - *Journal of Speech, Language and Hearing Research, Vol 58 (6) Dec 2015, 1793-1804.*
    - *The objective of this paper was to examine the impact of perceptual, linguistic, and capacity demands on performance of verbal working-memory tasks in a group of 45 native English speakers and examine the interplay between perceptual, linguistic, and capacity demands on verbal working memory performance. Steady-state noise did not have adverse effects on working memory in every situation. Noise did negatively affect high linguistic demand tasks. Of interest, the finding that adverse effects of background noise were not confined to conditions involving declines in recognition.*

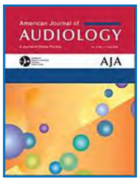
- Page 24: Paul Van Doren:
  - Danish reading span data from 283 hearing-aid users, including a sub-group analysis of their relationship to speech-in-noise performance.
    - *Eline Borch Petersen, Thomas Lunner, Martin Vestergaard & ElisabetSundewall Thorén.*
    - *International Journal of Audiology 2016; Vol 55: 254–261.*
    - *The authors found an obvious relationship between a declining working memory and poorer results in the speech–in-noise test. However the results were not significant for the SPIN test with speech and noise from different angles.*

- Page 26: Paul Van Doren:
  - Daily music exposure dose and hearing problems using personal listening devices in adolescents and young adults: A systematic review.
    - *Wen Jiang, Fei Zhao, Nicola Guderley & Vinaya Manchaiah.*
    - *International Journal of Audiology 2016; 55: 197–205.*
    - *In this comparative study, the authors are forcing us to look at the obvious risk of hearing damage in young people by the use of personal listening devices. Up to 60% of participants have a complaint related to their hearing.*

- Page 27: Katrien Hoornaert:
  - Using probe-microphone measurements to improve the match to target gain and frequency response slope, as a function of earmould style, frequency, and input level.
    - *Kevin J. Munro, Reema Puri, Judith Bird & Mark Smith.*
    - *International Journal of Audiology 2016; 55: 215 - 223.*
    - *Real ear probe-microphone measurements can be used to improve the match to the prescription target, but few studies have examined the match to the prescription target at multiple input levels. This study measures at low (50 dB SPL) and high (80 dB SPL) input, compared to 65 dB SPL. Both gain and frequency responses are studied.*

- Page 29: Barry Downes:
    - Speech-in-noise enhancement using amplification and dynamic range compression controlled by the speech intelligibility index
        - *Henning Schepker, Jan Rennies & Simon Doclo*
        - *J. Acoust. Soc. Am. 138 (5), November 2015, 2692–2706.*
        - *This article proposes a pre-processing algorithm that is capable of increasing speech intelligibility in the presence of different types of background noise for use in a variety of speech communication applications.*
- Page 31: Lorenzo Notarianni:
    - The Effect of Short-Term Auditory Training on Speech in Noise Perception and Cortical Auditory Evoked Potentials in Adults with Cochlear Implants.
        - *Nathan Barlow, Suzanne C. Purdy, Mridula Sharma, Ellen Giles & Vijay Narne.*
        - *Seminars in Hearing, Issue 01 Vol 37 February 2016, 84-98.*
        - *The scope of this research was to investigate whether a short intensive psychophysical auditory training programme is associated with speech perception benefits and changes in cortical auditory evoked potentials (CAEPs) in adult cochlear implant users.*
- Page 33: Barry Downes:
    - Exploring the Relationship Between Working Memory, Compressor Speed, and Background Noise Characteristics
        - *Barbara Ohlenforst, Pamela E. Souza, & Ewen N. MacDonald*
        - *Ear & Hearing, Vol. 37, No. 2, 137–143.*
        - *This study expands on previous research by exploring the effect of background noise modulations in relation to compression speed and working memory ability, using a range of signal to noise ratios.*

Relating Hearing Aid Use to Social and Emotional Loneliness in Older Adults.



Barbara Weinstein, Lynn Sirow & Sarah Moser.

American Journal of Audiology, Vol 25 (March 2016), 54-61.

Social relationships are important for our health maintenance, especially in the older population. The bigger one's social network, the less that a feeling of isolation or loneliness appears. The sense of loneliness contains two important subcategories: social and emotional loneliness. Loneliness can be defined as the difference between the person's desired social involvement and their daily social life. Loneliness has two aspects: the social loneliness (narrow or absence of social network) and the emotional loneliness (absence of intimate relationship). The range of social functioning can vary between full social participation to social isolation and loneliness. Factors that can cause loneliness are demographic, social, psychological, sensory or physical as well as HL (hearing loss).

Hearing loss is a risk factor for loneliness. That's why this study investigated three aspects:
(a) If first time Hearing Aid users have a reduced subjective sense of social and emotional loneliness after using hearing aids for 4-6 weeks.
(b) If there is a difference between people with typical to mild hearing loss and people with moderate-to-severe hearing loss before and after the intervention.
(c) What impact hearing aid use has on loneliness categorisation ("lonely" vs. "not lonely").

The examined group consisted of 40 adults (62-92 years old) searching for an audiological treatment with hearing aids in a private practice setting. Risks for middle ear, inner ear or retrocochlear pathologies were excluded. The same for cognitive dysfunctions and risks for social or emotional loneliness.

The DG Loneliness Scale was used to investigate the feelings of emotional and social loneliness. This scale was filled out before fitting and a second time after 4-6 weeks of hearing aid use.

For the performance on the Loneliness Scale, a significant reduction was discovered on the emotional subscale (M=1.23 before and M= 0.83 after) and on the total scale (M=2.55 before and M=1.87 after). There was also a reduction in the social subscale (M=1.33 before and M=1.08 after), but this difference wasn't statistically significant.

This shift in sense of loneliness was also statistically significant in our subgroup with moderate-to-severe hearing loss. On the other hand, there was no significant difference in relation to the age of the test group.

If we divide the group into "lonely" and "not lonely", we discover a significant shift from "lonely" (from 45.0% to 27.5%) to "not lonely" (from 55.0% to 72.5%) by comparing before and after 4-6 weeks of hearing aid use.

The use of hearing aids has a protective effect in our moderate-to-severe hearing loss subgroup, which showed a higher sense of loneliness. Although the reduction of the sense of loneliness in our subgroup of individuals with typical hearing to mild hearing loss is feeble, hearing aid use may reduce the risk of developing negative effects.

The health status and functional deficit are better predictors for loneliness than age. The same was found for perceived psychological hearing difficulty as a predictor for loneliness, rather than the severity of the hearing loss. The researchers suggested that audiologists consider obtaining an estimation of the patient's social network size and integration and their social/emotional loneliness state (they suggested using the DG six-item Loneliness Scale which is briefer, reliable and valid).

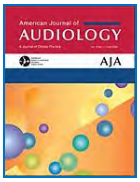
Although the study had its limitations, like the socioeconomic and ethnic homogeneity of the group or an existing lack of sense of loneliness before fitting, the effect of wearing hearing aids has been proven. This study gives a basis for more research. A longitudinal study has been suggested.

This study further noted that 45% of the participants were lonely before using the hearing aids and the same reduced to 27.5% within 4-6 weeks. This is rather quick, however, one should also note that there were still participants who did not show any change in loneliness. The authors concluded that this study showed evidence that hearing aids, by alleviating communication difficulties, are able to address even psychological issues such as loneliness. The authors recommended a better controlled study for deeper understanding of this phenomenon.

This is a simple yet powerful study conducted in a private practice setting. The study tried to address much needed information on effects of hearing aid use. Some variables such as other chronic health issues and family support should have been controlled better for clearer results. The best part of the study is that it has provided an example for private practitioners to conduct more of such studies. Also, the study makes an important point to be discussed with the prospective users on benefits of amplification.

In the counselling session and through the hearing rehabilitation process, we are trying to understand the difficulties our patients are facing and address them. This article raises our awareness to the loneliness factor that can be influenced by HA use. Our obligation to our patients is not only give them hearing aids but also to make sure that we are doing our best to fit them well, instruct the patients and make sure that the HA fitting is successful. Failing to do so may compromise the patient's hearing rehabilitation journey and, among other downsides, will increase their loneliness and keep them from engaging in social and emotional relationships.

Phoneme and Word Scoring in Speech-in-Noise Audiometry.



Billings C, Penman T, Ellis E, Baltzell L & McMillana G.

American Journal of Audiology, Vol. 25 (March 2016), 75–83.

As a profession, we know that many individuals experience speech perception in noise difficulties. In clinical testing, however, speech testing in quiet is still the clinical norm. The authors propose that one of the reasons as to why speech in noise testing is not routinely included in testing has been down to time constraints. This paper sets out to establish phoneme based scoring guidelines and to understand the effects and effect sizes of word and phoneme based scoring on clinically relevant factors of age and hearing impairment.

The researchers outline the benefits and drawbacks of using phoneme scoring over whole-word scoring, i.e. reduced variability in scores and information about specific phoneme errors. The drawback is the difficulty in comparing scores due to tester bias and differences in dialect between the tester and testee.

The purpose of this study was to (a) establish phoneme scoring guidelines, (b) apply these guidelines in testing older and hearing-impaired groups, and (c) determine if scoring method (word vs. phoneme) modifies the effects of age and hearing loss.

The participants were split into three groups based upon age and hearing loss level. Speech in noise testing was used measuring both phonemes and word testing. The researchers found that phoneme scores were up to about 30% better than word scores. Word scoring resulted in larger hearing loss effect sizes than phoneme scoring, whereas scoring method did not significantly modify age effect sizes. There were significant effects of hearing loss and some limited effects of age; age effect sizes of about 3 dB and hearing loss effect sizes of more than 10 dB were found.

In summary, results from word and phoneme scoring used in this experiment indicated a large and significant effect of hearing loss on speech perception in noise. A smaller effect of age was significant or near significant when word scoring was used. It was not surprising that phoneme scoring led to better overall SNR50s and SNR70s but only modified the hearing loss effect significantly (no change on the age effect) such that word scoring resulted in a larger hearing loss effect than phoneme scoring.

Open Versus Closed Hearing-Aid Fittings: A Literature Review of Both Fitting Approaches.

Alexandra Winkler, Matthias Latzel & Inga Holube.

Trends in Hearing 2016, Vol. 20: 1–13.

Sealing the ear canal while wearing a hearing aid causes occlusion. The acoustic mass of the vent is an important factor governing objective and subjective occlusion. The acoustic mass depends on the length and the square of the diameter of the vent. Reducing length or increasing diameter of the vent can be a good solution to occlusion problems.

Open-fit hearing aids will lead to better sound quality, improved own-voice perception, localisation and comfort. Important in open-fit hearing aid fitting is to perform adjusted REM measurements when required and to prevent artefacts caused by interaction of the direct and amplified sounds. Limitations for open fitting are decreased benefit of adaptive features such as directional microphones or noise reduction. The maximum gain before feedback also is reduced in open fittings.

Conclusions
The main factor in deciding which vent is most suitable is the amount of hearing loss. Nevertheless individual needs and listening circumstances should always be taken into account.
In general when hearing in low frequencies is nearly normal and up to 70 dB HL maximum at mid/high frequencies open fittings with hollow earmoulds, domes, or a large vent are recommended. In all other situations closed fittings are most suitable with consideration of active occlusion algorithms to reduce occlusion effects.

In the future, inventions with variable vents to adjust vent size according to the listening condition should be further analysed. When the user is talking, gain could be reduced and vent size enlarged, while in other listening conditions vent size is reduced and gain is higher.

For audiologists and experienced hearing aids users the occlusion effect phenomenon is well known. For firs- time hearing aids users it is something completely new. Counselling patients on the occlusion effect and advantages of open versus closed fitting strategies is very important. First-time users with occlusion problems could get used to occlusion by adjusting the acoustic mass and raising the gain gradually during the trial period.

Reference
Aazh, H., Moore, B. C. J., & Prasher, D. (2012a). The accuracy of matching target insertion gain with open-fit hearing aid. American Journal of Audiology, 21, 175–180.
Aazh, H., Moore, B. C. J., & Prasher, D. (2012b). Real ear measurement methods for open fit hearing aids: Modified pressure concurrent equalization (MPCE) versus modified pressure stored equalization (MPSE). International Journal of Audiology, 51(2), 103–107.
Dillon, H. (2012). Hearing aids (2nd ed.). Stuttgart, NY: Thieme.
Naumann, F. (2012). Inflatable ear piece with pressure relief valve. Patent No. WO 2012007067 A1.

Revealing Hearing Loss: A Survey of How People Verbally Disclose Their Hearing Loss.

Jessica West, Jacob Low & Konstantina Stankovic.

Ear and Hearing 2016; Vol. 37, N° 2, 194–205.

The stigma of hearing loss has, as we know, lead to many people coping with increasing levels of social and emotional isolation over years, sometimes even decades. This paper explores the reasons for nondisclosure and examines strategies for enabling verbal disclosure by developing a 15 question survey.

Audiologists often incorporate elements of disclosure within their initial interviews with patients newly reporting concerns with their hearing, and this study may enrich offer theoretical understanding and provide a base for further development of the model.

Study Design and Methods

The study was quite large; 672 people were invited to participate, a total of 337 participants provided qualitative data. 165 of these were women with an average age of 57.2, and 141 men with an average age of 55.9.

The participants completed a 15-question survey about verbally disclosing hearing loss.

Results and Discussion

When examining the phrases used to tell people they have hearing loss, the results revealed 3 strategies:

- *Simple purposeful disclosure where participants used this strategy to ask for something "I'm hearing impaired and I need you to look at me". They named this multipurpose disclosure.*
- *Basic disclosure, where a descriptor label such as "hard of hearing" is used during verbal disclosure*
- *Nondisclosure by which the participants don't mention hearing loss, but simply ask the other person to speak up or repeat the sentence.*

The objective variables (age; sex; type, degree, and laterality of hearing loss) and self-reported variables (degree of hearing loss; age of onset and years lived with hearing loss; use of technology; hearing handicap score) and the type of reactions were compared between patients and resulted in significant correlations between different variables and the 3 strategies. Women were more likely use multipurpose disclosure, while men tend to prefer basic disclosure.

With the second of the three categories, further significant determinants including gender, comfort over time to disclose, other people's negative reactions to disclosure, and the cause of the hearing impairment, all influenced the participant's choice of this strategy.

The results from the third category correlated to other research on hearing loss coping strategies, that we are all familiar with, including controlling versus avoiding social environments.(Hallberg and Carlsson 1991)

A key issue seems to be one of identity, and how this is managed socially and emotionally in all the areas of social interaction : home , work and relationships.

The researchers considered Southalls (Southall et al 2011) work on audiological rehabilitation and disclosure for creating identity management, and conclude that by including a variety of different phrases and disclosure strategies, communication and interactions may become more beneficial for the person with the hearing loss and their communication partner.

Conclusions

One of the major findings of this study was that three strategies are used for verbally addressing hearing loss. It is recommended to inform people with hearing loss about the different strategies that *can be used in a variety of contexts to improve their experience of disclosing hearing loss and to educate society at large about strategies for interaction with those with hearing loss.*

Reference
Jennings, M. B., Southall, K., Gagné, J. P. (2013). Social identity management strategies used by workers with acquired hearing loss. Work, 46, 169–180.
Southall, K., Jennings, M. B., Gagné, J. P. (2011). Factors that influence disclosure of hearing loss in the workplace. Int J Audiol, 50, 699–707.

This article increases our understanding of disclosing hearing loss. Hearing loss is the most common sensory deficit and it is stigmatised. Importantly the study reveals that the type or degree of hearing loss not a significant factor in disclosure, leaving the field open for further research on the clinical implications of disclosure behaviours and strategies

The benefits of disclosure are well documented in the literature, such as greater self-esteem, better peer relationships, lower anxiety levels and access to accommodations. People with nondisclosure have a lower quality of life and no psychosocial support. However, the negative effects of disclosure can be discrimination, becoming the object of curiosity, being treated differently, being overlooked for a job or promotion.

Conclusion is to weigh the consequences when deciding to disclose or not. The way to disclose is important too. People who disclose tend to control to social scene or to avoid it.
Disclosure management should be improved in the future. Multipurpose disclosure with focus on how the communication setting could be improved could be useful.

This research is based on reported phrases of the patients. In the future, the family of patients with hearing loss could be included in completing questionnaires. People aren't always aware of how they really disclose in daily life. This makes it difficult to fill in the questionnaire correctly. While conducting anamnesis, the patient's communication partners (family or friends) often add valuable information about patients' disclosure techniques too.
More research within different patient populations is necessary for validation of different strategies. Social and cultural variables could be significantly different in different disclosure strategies.

An interesting paper leading to a reflection of how and why we develop nature and respond to disclosure within our clinical practice.

Feasibility of conducting a randomized controlled trial to evaluate the effect of motivational interviewing on hearing-aid use

Hashir Aazh

International Journal of Audiology, 2015; Vol. 55(3), 149-156.

New hearing aid users often resort to irregular use. A British survey showed that 40% of the users wear the device for less than 4 hours of day. The situation is akin to non-adherence to long-term medical treatment procedures. In such cases, motivational interviewing technique seems to help in convincing the patients. Motivational interviewing (MI) is described as a collaborative conversation style for strengthening a person's own motivation and commitment to change. The author strongly believes that MI has a potential in improving hearing aid use.

Before a full-fledged Randomised Control Trial is carried out, the author aimed at conducting a single-blinded pilot randomised parallel-group study.

37 adult participants were blindly assigned into 2 groups – Standard Care (SC) and Motivational Interviewing with Standard Care (MISC). The participants were recruited after a thorough identification of irregular use of hearing aids in response to questionnaire surveys. SC group (n=17) received routine fine-tuning, counselling, demonstration etc. in a 60 minute individual appointment. MISC group (n=20) received an additional 60 minute appointment in which MI was delivered as per the MI principles and the sessions were video recorded and later were rated by an independent MI expert to check if it adhered to the MI principles as per a rating scale.

The intervention was provided during the baseline appointment and final assessment was done during a follow-up appointment after about a month for all the participants. All participants completed the RCR (Readiness to Change ruler), IOI-HA (International Outcome Inventory for Hearing Aids), GHABP (Glasgow hearing Aid Benefit Profile), MITI (Motivational Interviewing Treatment Integrity assessment tool), COSI (Client Oriented Scale of Improvement), WHO-DASII (World Health Organization's Disability Assessment Schedule II), and HADS (Hospital Anxiety and Depression Scale) questionnaires. However, only 78% of the participants completed the CERQ (Cognitive Emotion Regulation Questionnaire). Nineteen significant others (51%) completed the IOI-HA-SO (International Outcome Inventory for Hearing Aid for the Significant Other).

Datalogging was also used as a measure of outcome of this intervention. The mean number of hours per day that people used their hearing aid(s) increased from one hour per day at the baseline to seven hours per day one month after the intervention in the MISC group, and from 1.3 hours per day to four hours per day in the SC group. There was a large between-groups effect for hearing-aid use.

All the questionnaires (both COSI and GHABP) also recorded a small but positive change in HA use patterns, one month after intervention. The change in hearing aid use seemed to favour MISC compared to SC only.
All sessions were successfully coded by an independent coder using the MITI. Table 4 shows the outcome of the MITI coding for the MISC and SC sessions. The MISC sessions were coded as consistent with MI while SC did not involve any aspects of MI.

The author concluded that MI is a suitable technique to deal with the problem of irregular use of hearing aids. He also strongly recommended the use of datalogging to study the effect of Motivational Interviewing.

This is a very unique study from several aspects – topic, subject selection, studying the quality of intervention. The study paves way for the use of motivational interviewing in another new area not thought of so far. Motivational Interviewing (MI) and its application is clearly demonstrated in the study.

The Just-Meaningful Difference in Speech-to-Noise Ratio.

McShefferty D, Whitmer WM & Akeroyd MA.

Trends in Hearing (2016): Vol.20, 1-11.

It is well known that people with SN hearing loss need higher SNRs (Speech-to-Noise ratio) in order to understand speech in most real life situations. Several features have been introduced in hearing aids to deal with the requirement for higher SNRs. Directional microphones make smaller increases in SNR but they seem to be insufficient for most users.

The authors have introduced the debate on whether any increase in SNR is Noticeable-Meaningful-Important. In a previous study they have shown that just-noticeable difference (JND) for a change in SNR, using sentences in same-spectrum noise, to be approximately 3 dB regardless of hearing loss. However it is not clear that how much of this JND is really meaningful for a given patient. In order to investigate this further, they coined a new term - the just-meaningful difference (JMD), as the minimum increase in SNR necessary for someone to seek an intervention, such as the uptake or renewal of a hearing device.

This study employed 4 experiments to determine the JMD using both objective and subjective methods. Items from a corpus of short sentences partially masked by a speech-shaped noise were presented in a two-interval fixed-level procedure. In all the experiments 2 groups of subjects were included, those with normal hearing and those with hearing loss. Participants compared the SNR of a reference interval with the SNR of a test interval, with the value of the change chosen from predefined sets of values. The value of the SNR JMD was calculated as the change in SNR which gave a significant (based on within-subject confidence intervals) increase compared with 1 response unit (Experiment 1) or to 50% affirmative (Experiments 2–4).

- *In Experiment 1 (N=32), participants performed a paired comparison better or worse rating task. Paired examples of reference and target intervals were presented, and participants were asked to rate the second presentation compared to the first. Results showed that, across all 32 participants, the JND for a change in SNR was 2.8 dB. NH participants gave a JND of 2.7 dB. HI participants gave a JND of 3.0 dB.*
- *In Experiment 2 (N=31), participants performed a derivative of the willingness-to-pay paradigm, probing whether participants were willing to swap devices. The yes or no task asked participants whether they would swap the reference SNR (which they were told represented their current device) for the improved SNR example (representing a new or different device). Results showed that for the -6 dB SNR condition, the JMDs for participants who had and had not tried hearing aids were 6 and 4 dB, respectively. For the +6dB SNR condition, the JMDs for both those who had and had not tried hearing aids were greater than 8 dB.*
- *In Experiment 3 (N=21), participants performed a novel subjective-comparison task that took clinical significance literally: they were asked whether they would be willing (yes or no) to attend the clinic for a given SNR increase (benefit) or decrease (deficit).*
- *In Experiment 4 (N=36), the same clinical significance task was re-examined using a different, larger set of participants and a reduced set of conditions. Results showed that, across all participants, there was a significant difference between mean JNDs in the -6 and +6 dB SNR conditions.*

In Experiments 1 and 4, participants also performed an SNR JND task to corroborate previous results and to examine how the JND compared to the JMD. The following table summarised JND and JMD values obtained in different experiments. JMD values varied between 3dB to 8 dB depending on the task.

This difference clearly shows that when the subjects were asked to take decisions based on SNRs of the sentence material presented to them, the decision-making process sets in, leading to the clear existence of JMD as a measurable outcome.

This study throws light on new outcome parameters called JMDs, which seem to have powerful implications for the development of new technology. The study was meticulously planned and the results were explained well. The authors were shy in explaining the implications.

The middle ear muscle reflex in the diagnosis of cochlear neuropathy

Valero MD, Hancock KE & Liberman MC

Hearing Research, 2016; Vol. 332, 29-38

Auditory neuropathy is a clinical disorder characterised by absent ABR and present OAEs. Recent studies have documented that a moderate degree auditory neuropathy is also seen in people with age-related hearing loss and noise induced hearing loss. In these cases, supra threshold ABR wave I amplitude is permanently reduced whereas the ABR peak V thresholds seem to correlate with the hearing status. This seems to be the result of selective damage of high threshold and low and medium spontaneous rate (SR) auditory nerve fibres which comprise of nearly 40% of the auditory nerve.

Low SR fibres of the auditory nerve also play a crucial role in mediating the reflexes – medial olivocochlear reflex (MOCR, suppresses the outer OHA activity thus protects IHCs) and middle ear muscle eflex (MEMR, increases the impedance of middle ear to protect inner ear). Their damage seem to initiate a vicious cycle wherein reduced reflex strength worsens cochlear damage, which further reduces the strength of the negative feedback, which may ultimately lead to hair cell loss and permanent threshold shifts.

However, there are no tests to identify the auditory neuropathy. The objective of this study was to measure reflex strength and reflex threshold in mice with noise-induced cochlear neuropathy.

Two groups of mice were used in the study and they were exposed to 'neuropathic noise' which is already shown in earlier studies to selectively cause damage to auditory neurons. In one group of mice, the authors attempted to study DPOAE and their contralateral suppression using wideband noise. In the other group of mice, the authors recorded middle ear wideband reflectance for chirps and studied the changes caused by contralateral presentation of wideband noise.

The recordings happened at several intervals post noise exposure - a day after the noise exposure and 2-6 weeks post exposure, in both the groups. There were some control mice also in both these groups which were not exposed to noise.

The authors recorded DPOAEs in the first groups of mice and also recorded the contralateral suppression caused by wideband noise. However, the suppression in DPOAE amplitude almost reversed when the middle ear muscles were paralysed.

In the neuropathic mice, the MEMR thresholds were permanently elevated (Fig.C) and the maximum amplitudes of the reflex effects were permanently reduced (Fig. E). Figures - A, B and D indicate the suppression of MEMR by contralateral noise. The inter-group differences were statistically significant for both amplitude and threshold and for measures taken either at the onset and the offset of the contralateral noise.

The authors reminded readers that the similar elevated or absent MEMRs are seen even in the unilateral VIII nerve tumours. They implied that these low and medium SR fibres trigger the facial motor neuron and when they get damaged due to noise, the MEMR activity reduces and the suppression of the same further subsides.

Based on these observations, the authors strongly recommend the use of simple MEMR tests elicited with wideband stimuli such as glides, clicks or WBN to help in detecting the moderate degree cochlear neuropathy caused by a variety of factors.

This study further reinforces the hypothesis that the cochlear neuropathy can be caused by noise. It has paved the way for diagnosing a subgroup of auditory/cochlear neuropathy using a simple test which is already in popular use. The study was very well designed and just needs verification from human subjects.

Untangling the effects of tinnitus and hypersensitivity to sound (hyperacusis) in the gap detection test

R.H. Salloum, S. Sandrige, D.J. Patton, G. Stillitano, G. Dawson, J. Niforatos, L. Santiago & J.A. Kaltenbach

Hearing Research, 2016; Vol 331, 92-100

In recent years the induction of tinnitus in animals has been demonstrated by using the gap detection reflex test. Animals with tinnitus show weakened gap detection ability for background noise that matches the pitch of the tinnitus. The usual explanation is that tinnitus fills in the gap, but it has been shown that tinnitus is commonly associated with hyperacusis-like enhancements of the acoustic startle response, that might potentially alter responses in the gap detection test.
The authors of this study hypothesised that such enhancements could lead to an apparent reduction of gap suppression, resembling that caused by tinnitus, by altering responses to the startle stimulus or the background noise.

In this study adult hamsters at the age of 60-70 days were exposed to sound at one of three levels (group A: 110 dB SPL for 2.25 h; group B: 115 dB SPL for 1 h; group C: 100 dB SPL for 4 h). The control groups were not exposed but were placed in silence in the exposure chamber for the same time period.
On the day after the sound exposures, auditory brainstem responses (ABRs) were recorded to assess the impact of the exposure on response threshold.
Behavioural tests used included measures of gap detection and acoustic startle reflex (ASR). Furthermore they used acoustic startle reflex measurements and gap detection test (quantification of a loss in the ability of animals to detect the presence of a silent gap embedded within a background noise).

2-6 weeks post-exposure the animals showed to types of response enhancements in the gap detection test. Type A enhancement was evident in startle growth curves as an increase in the amplitude of the startle response in the absence of background noise. The Type B enhancement effect was apparent in the results of the gap detection test as an increase in the suppressive effect of background noise on startle responses. Both enhancements occurred together but had opposing effects on the results of the gap detection test.

The most dramatic effect was observed when the Type B enhancement dominated (group A animals), the startle amplitude in exposed animals was reduced below that of the controls in the "no gap" condition. This weaker startle had the effect of increasing the gap suppression ratio. However, unlike the increase in ratio caused by tinnitus, which raises the ratio's numerator, the increase in the suppression ratio caused by Type B enhancement was a 'pseudo-tinnitus' effect caused by a decrease in the ratio's denominator.

In animals of group B, the type A enhancement also sometimes dominated. A dominant Type A effect was recognised by the fact that the startle amplitude was significantly stronger in exposed animals than in controls for the "no gap" test condition. The stronger amplitude decreased the suppression ratio by increasing the ratio's denominator.
Type A enhancements can thus mask or 'neutralize' the effect of the tinnitus on gap detection test.

In group C, both enhancements are of similar strength. Both enhancements were present but the Type B effect was counterbalanced by a Type A effect of approximately similar strength, such that the two opposing forces cancelled each other out. A state of balance between the two enhanced response types was easily recognised by the fact that there was no significant difference between exposed and control animals in their responses to startle stimuli in the "no gap" condition. Although Type A und B enhancements were present, their effects of inducing either pseudo-tinnitus or neutralising effects on tinnitus were negligible. Since ABR thresholds were unchanged in this group, the increase in the gap suppression ratio could not be attributed to loss of hearing sensitivity. These *results thus demonstrate an ability to disentangle tinnitus from hyperacusis-like responses and bolster the interpretation that the animals had developed tinnitus.*

Furthermore other effects on hearing my influence the gap detection test: slowed temporal processing due to intense sound exposure. This could be avoided by using gaps with ramped onset and offsets (Sun et al., 2014).

Although the theory of the gap detection method is that tinnitus fills the gap, other mechanisms have been proposed (Fournier and Herbert (2013) and two other findings have challenged the view that tinnitus fills in the gap (Campolo et al. (2013), Boyen et al. (2015)).

The authors conclude that they believe that the gap detection method, when used to supplement other evidence, remains a valuable tool for tinnitus studies, but that interpretation of the results need to be made with caution with due attention given to the potential confounding effects of hearing loss and hyperacusis-like responses.

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Cochlear implantation as a long-term treatment for ipsilateral incapacitating tinnitus in subjects with unilateral hearing loss up to 10 years.

Griet Martens, Marc De Bodt & Paul Van de Heyning

Hearing Research, 2016; Vol 331, 1-6

The study aimed to do a long-term analysis of the tinnitus reduction in the unilateral hearing loss (UHL) study cohort of Van de Heyning (2008) ten years after CI.
The LT evaluation was derived from 23 subjects, which where categorised in two groups: a Single-Side Deaf Group (SSD) and a Asymmetric Hearing Loss Group. They were cochlear implanted at median age of 55 years (22-71 yr) and had 8 years (3-10 yr) experience with their CI at LT (long-term test-interval) testing.
For the LT testing several tests were done: structured interview, visual analogue scale (VAS), tinnitus questionnaire (TQ), hyperacusis questionnaire (HQ) and statistical analysis.
The results showed that all patients (23/23) wear their CI seven days a week, 8 years (3-10 yr) after cochlear implantation. 22 of them indicated that CI switch-on is the first act when arising and CI switch-off is the last act before bedtime. Interestingly the SSD group reported tinnitus suppression as the primary benefit whereas the AHL group reported improved hearing. In the majority of the subjects (55 %) the tinnitus decreases significantly within 1 min after CI switch-on (in 70 % of the cases) and the residual inhibition after CI switch-off is less than a minute (in 65 % of the cases).

VAS was done preoperatively, one, three, six, 12, 36 months after the first-fitting and at the LT test interval. The VAS score improved from preoperatively 8 (7-10), to 4 (0-7) one month after the first-fitting and to 3 (0-7) 3 months after the first-fitting. After that the VAS score remained constant. There was no significant difference between the preoperative VAS score and the VAS score with switched-off CI at LT test interval.
The median TQ score improved from preoperatively 55 (27-78) to 41,5 (4-64) one month after the first-fitting and to 31 (5-59) 3 months after the first-fitting. At the subsequent test intervals the TQ score also remained constant. So after a long-term of 10 years the tinnitus reduction is significantly stable.

In the SSD group a significant difference was found for the total HQ score between the CI(on) and CI (off) conditions. No significant differences were found within the AHL group. So the CI reduces significantly hyperacusis (measured with the HQ) in the SSD group but not in the AHL group.

Since this paper is the first study to report on LT results in a large number of UHL CI users I would recommend this paper.

Van de Heyning, P., et. al., 2008. Incapacitating unilateral tinnitus in single-sided deafness treated by chochlear implantation. Ann. Otol. Rhinol. Laryngol. 117 (9), 645-652..

Effects of Steady – State Noise on Verbal Working Memory in Young Adults.

Nicole Marrone, Mary Alt, Gayle DeDe, Sarah Olson & James Shehorn.

Journal of Speech Language and Hearing Research. 2015; Vol. 58 , 1592-1600.

Speech communication involves multiple auditory and cognitive mechanisms to hear, understand, and make use of information in spoken language. In daily life, performance on verbal tasks involves more than recognition and is influenced by the relative demands placed on the auditory-cognitive system. Performance may decline due to changes in the auditory environment, such as degradation of the acoustic signal with background noise, reverberation, distortion, or filtering of speech.

Rabbit (1966 – 1968) examined the effects of modulated noise on young adults' ability to recall lists or details of discourse passages presented auditorily. Even after controlling for the intelligibility of the speech presented in noise, Rabbit found that young adults were less likely to correctly recall lists of eight digits and remembered fewer passage details in noise compared with when stimuli were presented in quiet.

When there is a linguistic mismatch due to adverse listening conditions, demands on working memory capacity increase, triggering explicit processing to map sound to meaning from the acoustic signal. In the test presented in this paper, 45 healthy adults between the ages of 18 and 30 years participated in the experiment. In addition to age, eligibility criteria included speaking English as a native language; normal otoscopy; pure-tone air condition thresholds of 20 dB HL or better in both ears (250 – 8000 Hz).

Individuals in three participant groups performed equally well on the working memory tasks in quiet conditions without background noise for small and large sets.
Individuals in three participant groups performed equally well on the working memory tasks in quiet conditions without background noise for small and large sets.

Extrapolating from the present results, the interaction between linguistic and perceptual demand on working memory may differ across populations. For example, populations with known perceptual challenges, such as individuals with hearing loss, may show interactions between noise levels even for the less linguistically demanding subtract – 2 span task.

For future research there are several details to examine in terms of how different types of listening conditions and cognitive tasks will interact and affect people with differing perceptual and cognitive skills.
Interesting study corroborating the well-known adverse effects of background noise on perceptual performance with serious imaginable implications on hearing aid outcomes and which hearing aid fitting strategies should take into account.

[Danish reading span data from 283 hearing-aid users, including a sub-group analysis of their relationship to speech-in-noise performance.](#)

Eline Borch Petersen, Thomas Lunner, Martin Vestergaard & ElisabetSundewall Thorén.

International Journal of Audiology 2016; Vol 55: 254–261.

For this article the authors used data from a large group of 238 hearing aid users, participants of former studies done by Oticon Hearing Aids. They compared the acquired data from studies where participants were tested with a Reading-Span-Test (RST) and a Speech-in-Noise test (SPIN). They were looking for evidence for the relation between the working memory and understanding in noise. The Danish reading span test consists of multiple phrases which are nonsensical or sensible to divert the test person from the real task: repeating the last or the first words of the sentences.

The Dantale II test uses sets five word sentences, each word has to be repeated. A part of the test was done with noise and speech from the same angle, the other part from different angles.

The distribution of the results of the RST are comparable with other studies, and indicate a decline of working memory due to age. Although the group of younger hearing aid users was much smaller, the results are consistent. On the other hand, there is a large distribution of results, if we look to the individuals, suggesting that small differences in performance have a large effect on the results (e.g. 3 additional words result in a score in the 75th percentile instead of the 50th.

The authors found an obvious relationship between a declining working memory and poorer result in the Speech-in-Noise test. However, the results were not significant for the SPIN test with speech and noise from a different angle. They found no explanation for these findings and suggest further investigation. They stated as well that inter-individual differences on the SPIN test could be explained by the different amplification strategies and settings of the hearing aids in the different studies (although noise reduction and directionality was always disabled).

This study has the advantage of the large group of participants, but the disadvantage of the different aims and settings of the study. However, again it gives us evidence for the fact that we should include a working memory test in the assessment of hearing impaired adults to make a difference between the influence of the Working Memory and Speech understanding in noise to give us more guidelines to individualize our fitting strategy.

Daily music exposure dose and hearing problems using personal listening devices in adolescents and young adults: A systematic review.

Wen Jiang, Fei Zhao, Nicola Guderley & Vinaya Manchaiah.

International Journal of Audiology 2016; 55: 197–205.

In this overview, the authors started with a pool of 169 papers to look for inclusion criteria described as: use of Personal Listening Devices, where the use was more than the 100% daily noise dose (85 dBA for 8 hours), listening in competitive noise and significant outcomes. Finally they found 26 studies to compare.

From the analyses they could derive the following statements: In all studies there is reporting of hearing symptoms (pain, tinnitus, hearing loss…) even up to 60% of the participants. Significantly worse thresholds were found using Standard and High frequency audiometry, OAE, even with participants who reported themselves as normally hearing. There is even evidence that problems worsen with the years. Males are more likely to expose themselves to higher levels (7dBA), even in non-competing noise and had more elevated thresholds than female participants.

While users tend to put the music levels higher in noise, the authors make a statement for the use of at least in-ear isolators instead of ear buds or open headphones, or, even better, active background noise reduction built into the earphones. They strongly suggest informing young people using educational programmes to alter the behaviours of these people in order to reduce the impact of this phenomenon. They launched also a quest for new standards for calculating maximum music exposure.

Again, and now with a comparative study the authors are forcing us to look at the obvious risk of hearing damage in young people. Up to 60% of participants have a complaint related to their hearing. Since we, as hearing aid dispensers, have a responsibility to care about hearing loss prevention too, we should promote more use of individual earbuds in combination with headsets and active noise reducing headsets to prevent overexposure to sound in noisy environments.

[Using probe-microphone measurements to improve the match to target gain and frequency response slope, as a function of earmould style, frequency, and input level.]

Kevin J. Munro, Reema Puri, Judith Bird & Mark Smith.

International Journal of Audiology 2016; 55: 215 - 223.

Real ear probe-microphone measurements can be used to improve the match to the prescription target, but few studies have examined the match to the prescription target at multiple input levels. This study measures at low (50 dB SPL) and high (80 dB SPL) input, compared to 65 dB SPL. Both gain and frequency responses are studied.

Gain: initial fit is consistently below target, especially for an input of 50 dB SPL and at 1 kHz in the open-fit group. The match to target was good at 0.5 kHz, where gain requirements were minimal, but poorer at the high frequencies especially for the open-fits. The adjustments after measuring REM improve the match to target, but the gain is still below target for 50 dB SPL input.
Slope: in custom fittings, the slope is quite similar to the target slope, but this is not the case for open fittings where there is more difference in slope, especially for the lower input at 1 kHz. REM-adjustment improved the match to the prescribed response slope, primarily by increasing gain at 1 kHz.
The proportion of initial fits within 10 dB of the target gain overall is lower for the low input levels than for the high input levels and lower for the open fittings than for the fittings with custom earmoulds. The proportion of initial fits within 10 dB of the target slope overall is similar for open and custom fittings at 65 dB SPL input, and lower for open fittings than custom fittings for 50 and 80 dB SPL input. After REM-adjustment, only the proportion of fittings within 10 dB of the target slope at 80 dB SPL stays under 85%.

Regarding the discrepancy between initial fit and target gain, we see that initial fit is well below target at all test frequencies, especially at 50 dB SPL. There is a particular problem at 1 kHz in the open fit. The under-fit for low input level may be a deliberate tactic of manufacturers (avoid feedback, reduce complaints about noise and make adaptation easier).
Regarding the discrepancy between initial fit and target response slope, there is a problem at 0.5-1 kHz and 1-2 kHz, because of the lack of gain at 1 kHz.
As can be expected, the REM-adjusted fit greatly improved the match to target gain and the match to target slope. The only exception is the match to target slope for the 2-4 kHz octave band for an input of 80 dB SPL in open fit: 25% of the fittings had a shallower slope because of the difficulty in matching the gain target at 4 kHz without exceeding the target at 2 kHz.

Comments and considerations:
The assumption that a better match to target results in better outcome for the patient is not investigated here. The conclusions are only regarding one model of hearing aid and software. The manufacturers may have used another speech-type signal (compared to ISTS) and the differences in speech spectrum could have led to differences in prescribed gain and frequency response. NAL-NL1 was used in this study, but has been superseded by NAL-NL2.

Conclusions:
Initial fit is inadequate for this model of hearing aid and software. REM improved match to target for all input levels, but even after REM: too low gain for low input level and too shallow high frequency slope for high input level.

Speech-in-noise enhancement using amplification and dynamic range compression controlled by the speech intelligibility index.

Henning Schepker, Jan Rennies & Simon Doclo.

J. Acoust. Soc. Am. 138 (5), November 2015, 2692–2706.

In many speech communication applications, such as public address systems, mobile telephones, or any audio device with speech output, a high quality of communication needs to be provided. However, in typical communication situations speech is degraded by noise and/or reverberation. The influence of these disturbances from noise often leads to reduced speech intelligibility and increased listening effort.

In this article a pre-processing algorithm (i.e., processing prior to presentation) is proposed which is capable of increasing speech intelligibility. The proposed AdaptDRC algorithm comprises two stages, an amplification stage and a dynamic range compression stage that are both dependent on the Speech Intelligibility Index (SII). Experiments using two objective measures and a formal listening test were conducted to compare the AdaptDRC algorithm with a modified version of another algorithm (ModSau) in three different noise conditions.

Although broadband amplification can easily be implemented, it may lead to an overload of the amplification system or to unpleasantly high sound levels. Therefore, it is desirable to design algorithms that are able to increase speech intelligibility in such a way that they maintain equal powers of both the unprocessed signal and the processed signal. A previous study, referred to in this article, compared a large variety of pre-processing algorithms in a subjective listening test. Results indicated that algorithms that used a DRC stage showed large improvements in stationary and non-stationary noises, while most gain amplification algorithms only improved speech intelligibility for stationary noises. This study extended the evaluation of the AdaptDRC algorithm by using additional types of noise and different speech material.

Evaluation Method

The proposed AdaptDRC algorithm was evaluated using both objective measures as well as by performing a formal subjective listening test. In both cases, the speech material was taken from the Oldenburg Sentence Test which consists of 120 sentences spoken by a German male speaker. As noise disturbance, three different noises were used, stationary car noise, speech-shaped noise (SSN) and non-stationary cafeteria noise. This allowed investigation of the impact of noises that are comparable in terms of their long-term spectra (SSN and the cafeteria noise) but differ in their temporal structure and noises that differ in their long-term spectra (SSN and the car noise) but are comparable in terms of their temporal structure.

The use of objective measures often provides a good indication about the performance of these algorithms and are, therefore, a valuable tool when designing algorithms. However, in some cases, results from objective measures and formal listening tests show contradictory results. So, the impact of speech pre-processing algorithms on speech intelligibility can only be properly assessed using subjective listening tests. Therefore, a formal listening test was conducted to compare the performance in terms of speech intelligibility as measured by the number of correctly understood words for both algorithms. The listening test was performed with eight subjects with normal hearing having pure-tone thresholds below 20 dB HL for between 125 Hz and 8 kHz. The mean age of the subject group was 25.9 years with the youngest subject being 23 years and the oldest 28 years. The focus of the formal listening tests was to measure the performance of the proposed AdaptDRC algorithm over a wide range of SNRs. This procedure was applied for every combination of noise and algorithm. In order to avoid any effect of training, each subject was familiarised with the speech test material prior to the listening test.

Results

Figure 6 below shows spectrograms for an unprocessed Reference, the ModSau algorithm, the AdaptDRC algorithm, and the cafeteria noise. As can be seen, both algorithms increase the speech power in the frequency range from about 2 kHz to about 10 kHz compared to the unprocessed Reference. However, comparing the AdaptDRC algorithm and the ModSau algorithm, the AdaptDRC algorithm leads to a larger increase in speech power in the high frequencies. It was concluded that an important factor creating this performance difference was the DRC stage of the AdaptDRC algorithm.

The objective measures indicated a similar performance for both algorithms, showing increased performance when compared to the unprocessed Reference. Results from the formal listening tests indicated that, for the two stationary noises, both algorithms led to statistically significant improvements in speech intelligibility. However, for the non-stationary cafeteria noise only the proposed AdaptDRC algorithm led to statistically significant improvements. The results of a formal listening tests showed that the proposed AdaptDRC algorithm was capable of significantly increasing speech intelligibility and outperformed the ModSau algorithm in non-stationary noise environments.

Conclusion

A difficult article to read due to the detailed, technical descriptions of pre-processing algorithms. However, it gives considerable insight into how such algorithms are developed and assessed with a view to the production of signal processing technologies with really can improve speech understanding in difficult listening conditions.

The Effect of Short-Term Auditory Training on Speech in Noise Perception and Cortical Auditory Evoked Potentials in Adults with Cochlear Implants.

Nathan Barlow, Suzanne C. Purdy, Mridula Sharma, Ellen Giles & Vijay Narne.

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Difficulty understanding speech in noise is a major factor contributing to poor uptake and usage of hearing devices. Although hearing devices are regarded as a primary rehabilitation option for people with hearing loss (HL), their usage does not always result in successfully understanding speech in noise with correlated risks of more depression, social isolation, diminished capacity to learn, cognitive decline, and reduced overall quality of life compared with people with normal hearing.

Auditory training typically focuses on improving auditory discrimination skills and almost without exception uses speech stimuli. The effect of training is variable, with either slight to moderate gains in speech perception or no benefit, depending on the training protocol used and the duration of the training.

In this study, ten adult cochlear implant (CI) recipients (aged 39 to 78 years – mean 55.36, SD = 13.67) with 1.7 to 4.3 years of CI experience (Mean 3.01, SD = 0.96) trained for 7 hours on psychophysical tasks such as gap in noise detection, frequency discrimination, spectral rippled noise (SRN), Iterated Rippled Noise, Temporal Modulation. Speech performance was assessed before and after training using Lexical Neighbourhood Test (LNT) words in quiet and in eight – speaker babble. The participants undertook objective and behavioural measurements four times, three times prior to and once after training. CAEPs evoked by natural speech stimulus /baba/ with varying syllable stress were assessed pre- and post-training in quiet and in noise. SRN psychophysical thresholds showed a significant improvement (78% on average) over the training period, but performance on other psychophysical tasks did not change.

There were four visits to the laboratory with 7 days of training between visits 3 and 4.The present study determined whether short-term computer-based auditory psychophysical training improved speech recognition in adults with CI and if altered speech scores would be reflected in the CAEPs. All 10 CI participants completed 7 hours of training over a week. The auditory training was associated with a small average improvement over time on all psychophysical measures, however, only SRN thresholds improved significantly between training day 1 and day 7. Although N1P2 CAEP amplitudes showed some changes post-training these did not correlate with behavioural post-training measures, and the pre- and post-CAEP difference was only significant for the unstressed speech stimulus /baba/.

Several factors contribute to variable CI outcomes such as duration of HL and age of onset of the severe to profound HL. Most of the participants in the current study were not successful HA users and had not used their HAs on a regular basis prior to implantation; therefore, the evidence for some auditory plasticity in this population provided by this study is encouraging. It is mentioned in this paper how, despite published evidence for training effectiveness, opinions and experiences of training benefits are often not reported but are an important consideration given the acknowledged poor compliance and lack of engagement in training. Hence, the importance of well-established and evidence-based protocols, be it in the HA or CI fitting procedures.

Exploring the Relationship Between Working Memory, Compressor Speed, and Background Noise Characteristics.

Barbara Ohlenforst, Pamela Souza & Ewen MacDonald.

Ear and Hearing 2016; Vol. 37, N° 2, 137–143.

INTRODUCTION

The study investigated the interaction between compression release time, speech intelligibility in modulated noise, and working memory. The influence of working memory was analysed by testing two groups of older adults, one characterised by lower working memory and the other by higher working memory, based on their performance on a Reading Span Test (RST). Measures of sentence intelligibility in noise were used in which compression release time and modulation properties were varied.
Working memory plays an active role in speech intelligibility, particularly when adults with hearing loss are in complex listening conditions. Older listeners show deficits in working memory as well as other abilities that may be involved in speech intelligibility, requiring simultaneous processing and storage by working memory. Older adults with hearing impairment that suffer from both loss of auditory information and a loss of information-processing capacity are, therefore, at a disadvantage in following complex conversations and find it especially effortful.

Previous research on the role of working memory in communication has demonstrated the importance of working memory with respect to amplified speech intelligibility. Listeners with lower working memory have shown reduced speech in noise intelligibility for fast-acting compared with slow-acting compression. In contrast, listeners with higher working memory were able to benefit more from fast-acting compression.

The reasons for the association between working memory and compression speed appears to exist only in modulated background noise are not well understood. Previous research has suggested that cognition might interact with the extent of modulation in background noise, meaning that listeners with higher scores from cognitive tests are able to use the temporal or spectral gaps in modulated background noise. These gaps allow the listener to "glimpse" information about the target signal but successful glimpsing is cognitively demanding as it requires the integration of disconnected speech information to restore the content of the speech signal and to derive meaning from it. The authors hypothesised that adults with lower working memory would demonstrate better scores for slow compression, whereas adults with higher working memory would demonstrate better scores for fast compression, and that the relationship between working memory and compression speed would be stronger when the noise contained greater modulation with greater opportunities for glimpsing.

A drawback of some compression amplification systems is that they introduce a variety of signal alterations that negatively affect use of modulation. Fast-acting compression (release times <200 msec) results in a compressor output with reduced modulation depth which reduces the information-bearing modulations in the speech signal. Fast-acting compression may also increase the similarity between the envelope modulations of the signal and the envelope modulations of a masking noise and, in modulated noise, the gain function of the compressor is dictated by the overall levels of the combined signal and noise.

METHODS

Participants
The present study included 26 participants with a mean age 73.92 years. All participants had mild to moderate sensorineural hearing loss with pure-tone thresholds ranging from 25 to 70 dB HL at octave frequencies between 250 and 6000 Hz.

Working Memory
The working memory of the participants was evaluated with a RST designed to simultaneously tax memory storage and information processing. The test required the participants to perform two tasks. The first task was to report whether or not a sentence had a sensible meaning. The second task was to recall either the first or the last word of a sequence of sentences in correct serial order. Based on their results of the RST task, the participants were separated into two groups. Nine participants had high working memory and seventeen participants had low working memory. There was no significant difference in age between the two groups and both had similar average audiograms

Hearing Aid Compression
The speech signal and the background noises were simultaneously presented through insert earphones. In this way, listeners heard a signal much like what would occur with a wearable hearing aid, but with greater experimental control and flexibility. The input speech level was 65 dB SPL. The attack time was always 5 msec. but two release times were applied: 40 msec. (short) or 640 msec. (long). The compression threshold was set at 45 dB SPL and a compression ratio of 2:1 was used.

Stimuli
Low-context sentence material was selected to facilitate comparison to previous work and to encourage decoding of acoustic information rather than guessing key words based on context. The sentences were sufficiently long to ensure that modulations, either in the signal or background noise, would allow for acoustic differences between fast and slow compression. Sentences were presented in a modulated background noise using three artificial noise signals (ICRA) with one-, two-, and six-talkers. The noise signals were designed for hearing instrument assessment and psychophysical evaluation.

Outcome Measurements
Speech intelligibility scores (as % correct) were obtained in each of the 18 test conditions (three fixed SNRs, three different background noises and two compression release times).

RESULTS
Mean speech intelligibility scores (in percent correct) for each group, compression speed, noise condition, and SNR were evaluated. Across all conditions, mean scores ranged from 23% to 79%. Higher scores were demonstrated at more favourable SNRs and in background noise with a smaller number of talkers (i.e., one-talker ICRA). The result of greatest interest was the difference between fast and slow compression.

A summary of the key results of the analysis is that this study is in agreement with earlier research and, on average, listeners with good working memory performed better with fast compression, whereas listeners with poor working memory performed better with slow compression. That relationship was constant across SNR. Regarding the effect of background noise modulations, the magnitude of the fast–slow performance difference depended on the number of background talkers, but only with substantially different background modulation characteristics (one-talker versus six-talker ICRA noises).

Conclusion
This is an interesting and well written article. Although broadly it confirms the conclusions of other, similar research on the association between compression speed and cognitive state, this article shows why this increasingly evidence-based association should guide the selection of hearing aid systems for many older adults. With this comes the challenging question as to whether audiology professionals working with older adults should undertake an appropriate cognitive assessment more routinely.