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- Page 04: Tine De Boodt & Anna Pugh:
  - The Effect of Age on Listening Effort.
    - *Sofie Degeest, Hannah Keppler & Paul Corthals.*
    - *Journal of Speech, Language, and Hearing Research , Vol. 58 , 1592-1600.*
    - *This article analyses the relationship between age and listening effort by using a dual-task paradigm (visual memory task and speech in noise test).*

- Page 06: Anna Pugh:
  - Self-Reported Hearing Difficulties Among Adults With Normal Audiograms: The Beaver Dam Offspring Study.
    - *Kelly Tremblay et al.*
    - *Ear & Hearing, Vol. 36, N°6, e290-e299.*
    - *The researchers don't yet seem to have any definitive cause for why people with normal hearing seem to feel that they have a hearing loss, and posit that the cause may be outside audiology research*

- Page 08: Anna Pugh:
  - Adults with mild hearing impairment: Are we meeting the challenge?
    - *Barbra H.B. Timmer, Louise Hickson & Stefan Launer.*
    - *International Journal of Audiology 2015; 54: 786–795.*
    - *We need to develop a real-world listening evaluation protocols, more appropriate assessment within our clinics, and that hearing health interventions are likely to be more successful when greater consideration is given to self-reported hearing disability.*

- Page 10: Sofie Peeters:
  - The Benefit of Remote Microphones Using Four Wireless Protocols.
    - *Krishna S. Rodemerk ; Jason A. Galster.*
    - *Journal of the American Academy of Audiology. 26: 724–731 (2015).*
    - *The results of this study revealed that use of the remote microphone systems statistically improved speech recognition in noise relative to unaided and hearing aid-only conditions across all four wireless transmission protocols at 6 and 12' away from the talker.*

- Page 12: Reddy Sivaprasad:
  - Cardiovascular risk factors and hearing loss: The HUNT study.
    - *Bo Engdahl, Lisa Aarhus, Arve Lie & Kristian Tambs.*
    - *International Journal of Audiology 2015; 54: 958–966.*
    - *This is a large prospective population study where hearing thresholds and cardiovascular measures were tracked over years. The study found that most cardiovascular measures can be associated with hearing loss but they can cause only a few dB (less than 0.5%) of hearing loss.*

- Page 13: Reddy Sivaprasad:
  - Hearing-aid use and long-term health outcomes: Hearing handicap, mental health, social engagement, cognitive function, physical health, and mortality.
    - *Piers Dawes, Karen J. Cruickshanks, Mary E. Fischer, Barbara E.K. Klein,Ronald Klein & David M. Nondahl.*
    - *International Journal of Audiology 2015; 54:11, 838–844.*
    - *This study is a cohort-observational study where a huge number of hearing-aid users and non-users with hearing loss were studied using a variety of outcome measures over 11 years. The results clearly show that hearing-aids reduce hearing disability and seem to have no long-term effects on other health parameters.*

- Page 14: Reddy Sivaprasad:
  - The Influence of Hearing Aid Use on Outcomes of Children With Mild Hearing Loss.
    - *Elizabeth A. Walker, Lenore Holte, Ryan W. McCreery, Meredith Spratford, Thomas Page & Mary Pat Moellerd.*
    - *Journal of Speech, Language, and Hearing Research , Vol. 58 , 1611–1625.*
    - *This is a multicentre study which studied a variety of issues ranging from identification to intervention provided to children with mild hearing loss. The outcomes of intervention especially the deep aspects of language seem to be affected easily if intervention is delayed or not provided. The authors even introduced a new concept called cumulative auditory experience in studying the outcomes for children.*

- Page 16: Lorenzo Notarianni:
  - Background sounds and hearing-aid users: A scoping review.
    - *Brian Gygi & Deborah Ann Hall.*
    - *International Journal of Audiology 2016; 55: 1–10.*
    - *This scoping review focused on background sounds and adult hearing aide users, including aspects such as aversiveness and interference. Main objectives being that of establishing a current body of knowledge, identifying knowledge gaps, and suggesting possible future directions for research. Data were gathered using public databases of published records between 1988 and 2014. Many conclusions are limited by methodological drawbacks in study design and too many different outcome instruments. Future research needed to address these issues, while controlling for hearing aid fitting.*

- Page 17: Lorenzo Notarianni:
  - Clinician-Supported Internet-Delivered Psychological Treatment of Tinnitus.
    - *Gerhard Andersson.*
    - *American Journal of Audiology, Vol. 24, 2015, 299–301.*
    - *Although Internet-delivered psychological treatment for tinnitus as a support for the clinician is not an entirely new concept, various studies on this methodology have been reviewed in this paper – the method holds promise as an alternative to other, standard forms of treatment delivery.*

- Page 18: Michael Joseph:
  - Is it necessary to occlude the ear in bone-conduction testing at 4 kHz, in order to prevent air-borne radiation affecting the results?
    - *Maryanne Tate Maltby & David Gaszczyk.*
    - *International Journal of Audiology 2015; 54: 918–923.*
    - *The authors conclude that occluding the test ear during the bone conduction procedure in pure-tone audiometry should be reconsidered and discontinued.*

- Page 19: Katrien Hoornaert:
  - Can a Remotely Delivered Auditory Training Program Improve Speech-in-Noise Understanding?
    - *Harvey B. Abrams, Kirsten Bock & Ryan L. Ireya.*
    - *American Journal of Audiology, Vol. 24, 333–337.*
    - *The results show no significant improvement in speech-in-noise understanding. The number of hours spent on Auditory Training influences the results of the WIN test (Words-in-Noise test), but not the results of the HINT test (Hearing in Noise Test).*
- Page 20: Barry Downes:
  - A Comparison of Two Methods for Measuring Listening Effort As Part of an Audiologic Test Battery
    - *Jani Johnson, Jingjing Xu, Robyn Cox & Paul Pendergraft.*
    - *American Journal of Audiology, Vol 244, 419–431.*
    - *The purpose of this study was to evaluate two measures of listening effort, a self-report measure and a word recall measure, to establish their suitability for inclusion in a comprehensive set of audiological measures which include both listening effort and speech intelligibility.*
- Page 22: Martine Van Passel:

- Evaluation of a BICROS System with a Directional Microphone in the Receiver and Transmitter.
    - *Michael Valente & Kristi Oeding.*
    - *J Am Acad Audiol 26:856–871 (2015).*
    - *The overall aim of this study is to examine if significant differences in sentence recognition in noise and subjective preferences are present between an Omni Directional Microphone and an adaptive broadband Directional Microphone programmed in the Microphone Component of a BICROS system compared with an automatic adaptive multichannel DM programmed in a Monaural “Receiver In the Ear” Device.*

The Effect of Age on Listening Effort.

Sofie Degeest, Hannah Keppler & Paul Corthals.

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

It is recognised that older people increasingly report difficulties hearing well in noisy social environments, and this is generally believed to be a consequence of a "natural" decline in cognitive function, speech processing issues and increasing hearing impairment. This really interesting paper looked at this issue from a challenging perspective: Is age really the main influence on success? To do this, they firstly identified a measurement strategy for determining success, and then established experiments to prove the proposition.

Bourland-Hicks and Tharpe 2002 defined "listening effort" as the point at which the individual requires higher level cognitive function to compensate for lower level loss of speech information. This is generally a result of the degradation of the signal due to increased extraneous noise. They proposed a measurement tool which required participants to perform two different tasks at the same time, or a "dual –task paradigm".

Current research articles on audiology and hearing aids focus more and more on the influence of cognitive factors with hearing aid users. Older people often complain of difficulties in understanding in noisy situations.

This study describes the relationship between age and listening effort by testing visual memory and speech in noise tasks on 60 adults aged between 20 and 77 years.

Firstly, participants needed to repeat digits in two different noise conditions: +4 dB SNR (favourable condition) and -10 dB (unfavourable condition). Secondly, a visual memory task was used to test mental effort. Both tests were conducted separately and simultaneously. Listening effort was calculated by the difference between the baseline scores and the dual test scores.

Older adults – as expected - tended to score worse in both conditions; this could be due to decline of lower-level sensory and perceptual processes. Another expected result was that listening effort increased with increasing age starting in the fourth decade of life. Importantly they demonstrated that even a +2dB SNR significantly influences success for people over 40 years. The "critical age" when listening efforts start to change is 44.1 years. Previous research didn't include middle-aged adults.

In conclusion, this research measured a clear relationship between increasing age and increased listening effort because cognitive functioning also declines, i.e. working memory, processing speed and selective attention.

This result could have an enormous impact on the middle-aged demographic who should be encouraged and enabled to begin seeking help with their hearing abilities.
Evidence also showed that there was a significant decline in speech perception linked to ageing in all listening environments, irrespective of hearing sensitivity.

Whilst the results of this study further confirm earlier research that older adults expended more listening effort than younger people (Gosselin & Gagne 2011), this study also proved a link with middle-aged participants and the progressive increase in listening effort.

Cognitive function is important for speech recognition in noise, and this study highlighted three aspects which are important, namely working memory, processing speed and selective attention, all of which decline with age.

If, as research suggests, cognitive function decline begins at 45, this study contributes to evidence of the need to increase listening effort. However, cognitive function was not specifically explored by this study. The researchers were, therefore, able to state that this study was a first exploration into listening effort for younger to older adults, and that, regardless of hearing sensitivity, listening effort increases with age.

This research didn't give new insights; in our practice we already use the reading span test to measure listening effort. However, this study highlights the importance of testing cognitive functions to counsel our clients. Future research should look for relationships between hearing aid use and age and listening effort. What is the effect of certain features and compression strategies? What is the effect of training for patients in middle-aged and older-aged groups?

The study concluded by recommending that testing for listening effort should be included in the assessment battery where patients report difficulties hearing well in noise, and I found myself having this very conversation with a patient this afternoon.

A reliable standardised testing protocol would, therefore, in my opinion, be a very welcome addition to a rehabilitation strategy.

- *Bourland-Hicks C, Tharpe AM 2002 Listening effort and fatigue in school age children with and without hearing loss. Journal of Speech, Language and Hearing Research 45, 573-584*
- *Gosselin P & Gagne JP 2011 Older adults expend more listening effort than young adults recognising speech in noise. Journal of Speech Language and Hearing Research 54, 944-958*

Self-Reported Hearing Difficulties Among Adults With Normal Audiograms: The Beaver Dam Offspring Study.

Kelly Tremblay, et al.

Ear and Hearing 2015; Vol. 30(6), e290-e299.

There are times when we all encounter patients who report hearing difficulties, but present with "normal" pure tone audiograms. Our usual response is to consider other aetiologies and refer onwards for further investigation and support. This has resulted in patients feeling "dismissed" or not believed (Pryce & Wainwright 2008).

The famous Beaver Dam study and population has generated further research into the hearing difficulties of the community, and this paper reports on the findings so far. The Beaver Dam Offspring Study (BOSS) is a longitudinal population study of sensory ageing in the adult children of earlier research participants, and has already provided a wealth of data on a wide range of metrics including socio-demographic and lifestyle factors, workplace noise exposure, cognitive function and medical history.

The paper provided some context for the study and discussed self-reporting difficulties and prevalence of hearing loss in the general population. I was surprised to read that researchers have estimated that up to 29% of patients presenting at ENT services will have normal audiometric thresholds, and took the opportunity to re-visit some earlier research to gain more insight into this (Garstecki 1987).

BOSS used the descriptor "normal hearing levels" to indicate average thresholds <20dBHL at 500Hz, 1KHz, 2KHz, 3KHz, 4Khz, 6Khz and 8KHz. A battery of other tests were performed including cochlea function, speech reception, speech in noise, and a full medical history was taken : workplace and or recreational noise exposure, tinnitus, vertigo, and self assessment based on the HHIE screening inventory.

The researchers also questioned the participants on mental wellness, cognitive function and visual acuity.

2783 local people participated in the study, and of these 682 had " normal " thresholds, with 82 reporting hearing difficulties, giving a prevalence rate of 2.9%

Tremblay reports a higher percentage of participants who reported hearing difficulties also " took more medication, visited a doctor more often for hearing loss, .. complained of tinnitus, ear infections, sinus problems and dizziness".

She suggests that these people may be experiencing noise–induced pathologies, indicating subclinical cochlea damage. However DPOAEs were performed and analysed, and no appreciative difference was evidenced within the "normal thresholds reporting hearing loss" group and the " normal hearing no loss" group. Further investigations of neuropathy also indicated no significant indication of cause.

Interestingly, the study results hint at a link to increased visual difficulties (Dawes 2014). The research concluded that there is an increased likelihood of reduced visual function, and depression, for participants reporting hearing difficulties.

The researchers don't yet seem to have any definitive cause for why people with normal hearing seem to feel that they have a hearing loss, and posit that the cause may be outside audiology research.

The paper began by asking why this happens, and, after a great deal of data collection and analysis, conclude that there doesn't seem to be a simple single answer, which is reassuring to all of us encountering patients with these issues in our clinics.

At least now we can say "I don't know, but there is a lot of research looking into how and why you feel like this", and take care not to dismiss these patients' concerns out of hand.

Dawes, P., Dickinson, C. M., Emsley, R., Bishop, P., Cruickshanks, K. J., Edmondson-Jones, M., McCormack, A., Fortnum, H., Moore, D. R., Norman, P., and Munro, K. (2014). Vision impairment and dual sensory problems in middle age. eScholarID:226874 | DOI:10.1111/opo.12138

Garstecki D 1987 Self-perceived hearing difficulty in aging adults with acquired hearing loss. Journal of the Academy of Rehabilitative Audiology 20, 49-60

Pryce H & Wainwright D 2008 Help seeking for medically unexplained hearing difficulties : a Qualitative study. International Journal of Therapy and Rehabilitation Vol. 15, No. 8, 2008, p. 343-349.

Adults with mild hearing impairment: Are we meeting the challenge?

Barbra H.B.Timmer, Louise Hickson & Stefan Launer.

International Journal of Audiology 2015; 54 786-795.

The topic of “mild hearing impairment” is a live issue in the UK at the moment, given the commissioning decision of North Staffs CCG to withdraw from the provision of free on loan NHS hearing aids. So, this research paper from the University of Queensland and Phonak is a timely contribution to the debate of services, definitions, measurement criteria and assessment.

Timmer and colleagues reviewed research literature concerning adults with acquired mild hearing impairments, and begin by opening the debate on definitions. They remind us of the World Health Organisations (WHO) International Classification of Functioning, Disability and Health (ICF), where a common language and understanding of impact is used to describe a “dynamic interaction between health conditions and contextual factors” (WHO 2001)

By applying the ICF framework to hearing impairment, Timmer states that simple audiometric measurements do not consider the limits and restrictions experienced by the patient on their activities and social participation.

Over the last 15years, over 150 pieces of research have been undertaken into this group of patients. This catalogue was then further distilled to meet the inclusion criteria of this study.

Unsurprisingly common descriptors of “mild hearing loss” appear to present the first hurdle to any research literature review. The Clark labels of “mild, moderate, severe and profound “are based on average thresholds from pure tone audiometric testing, (Clark 1981), and are seen to be widely adopted to provide a framework for comparison. However even this creates issues. For example, in the early 1990s both WHO and ASHA had an additional descriptor of “slight” hearing loss with averages of 16-25dBHL when tested over 500Hz, 1KHz, and 2KHz (3FAHL – 3 frequency average hearing loss) , and a further “ mild” category averaging 26-40dBHL. WHO then later revised this to “slight” drawn from 4FAHL of 25-40dBHL when tested at 500Hz, 1KHz, 2KHz and 4KHz.

*In the UK, we use the standards established by the British Society of Audiology which set the mild descriptor as 20-40dBHL at a 5FAHL of 250Hz, 500Hz, 1KHz, 2KHz, and 4KHz. (BSA 2011)
In the light of this inconsistency, the researchers point out that NAL base their prescription fitting algorithms on a descriptor of “mild” from 21-45dBHL over 3FAHL of 500Hz, 1KHZ and 2KHz.
This variance in definition has influenced the ability of earlier researchers to quantify prevalence and the functional impact of a “mild hearing loss”. The paper addresses this by considering some of the recent demographic population studies, including the famous Beaver Dam Offspring Study*

The issue of impact provided further scope for study, in particular where some research indicated that people with mild hearing loss “do not experience disability” , yet others concluding that “ even a very mild (slight) loss at 3FAHL of 15dBHL can be significantly disabling” (Lutman et al 1987)

Furthermore the research included Weinstein and Kentry’s findings that report that “hearing thresholds account for less than 50% of the variance in reported hearing handicap” (Weinstein and Kentry 1983).

This literature review also considers various outcome measures to categorise and identify ‘hearing handicap’ including speech-in-noise testing, speech reception, health quality of life self-reporting patterns, the adoption and benefits of assistive devices and hearing aids, and external factors such as occupational noise exposure.

The article concludes by saying that we need to develop real-world listening evaluation protocols, more appropriate assessment within our clinics, and that hearing health interventions are likely to be more successful when greater consideration is given to self-reported hearing disability.

I found this to be a really useful article for prompting me to revisit some earlier studies on assessment and outcomes, and has lead me to reflect on my clinical engagement with patients with "mild hearing loss". It's certainly a paper I would recommend.

British Society of Audiology 2011Recommended Procedure Pure-tone air-conduction and bone-conduction threshold audiometry with and without masking

Clark J.G 1981 Uses and abuses of hearing loss classification, ASHA 23,493-500

Cruikshank K J, Wiley TL, Tweed TS, Klein BE, et al 1998 Prevalence of hearing loss in older adults in Beaver Dam Wisconsin. The Epidemiology of Hearing Loss study. American Journal of Epidemiology 148, 879-886.

Lutman M., Brown E.J. & Coles R.R.A. 1987. Self-reported disability and handicap in the population in relation to pure-tone threshold, age, sex and type of hearing loss. Br J Audiol , 21 , 45 – 58 .

Weinstein B.E. & Ventry I.M. 1983. Audiometric correlates of the hearing handicap inventory for the elderly. J Speech Hear Disord, 48, 379 – 384.

The Benefit of Remote Microphones Using Four Wireless Protocols

Krishna S. Rodemerk ; Jason A. Galster

Journal of the American Academy of Audiology. 26: 724–731 (2015)

The primary goal of this investigation was to determine the speech recognition benefits of four different commercially available remote microphone systems, each with a different wireless audio transmission protocol.

Sixteen adults, ages 52 to 81 years, with symmetrical, mild to severe, sensorineural hearing loss participated in this study. Ten participants were experienced hearing aid users and six participants were non-users. None of the non-users had experience with hearing aids at all prior to this study.

The participants were fitted with three different sets of bilateral hearing aids and four commercially available remote microphone systems.

Hearing aids	Remote microphone system	
Starkey 3 Series i110 mini BTE	Surflink Mobile Remote Microphone	900 MHz
Phonak Ambra SP	MicroMLxS Receiver + Campus SX static FM transmitter	FM Carrier frequency: US: 216 MHz Europe: 170 MHz
Phonak Ambra SP	Com Pilot + Remote mic	Bluetooth paired with near field magnetic induction
ReSound Alera TS 977DW BTE	ReSound Unite Mini Microphone	2.4 GHz

All participants were fitted with acrylic, full-shell, occluding earmoulds. Real-ear aided responses were collected to ensure that the output of each hearing aid matched within +/- 5 dB of DSL v5 adult targets. The participants' individual settings were as follows:

1	Omnidirectional hearing aid-only setting	Except for feedback suppression, all other features and noise reduction algorithms were deactivated
2	Remote microphone setting	The hearing aid microphone was muted. Except for feedback suppression, all other features and noise reduction algorithms were deactivated
3	Remote microphone setting included contributions from the hearing aid microphone (omnidirectional)	The remote control and the hearing aid microphone were set such that each contributed equally to the audio signal. Except for feedback suppression, all other features and noise reduction algorithms were deactivated

Speech recognition scores were measured by an adaptive version of the Hearing in Noise Test (HINT).

The participants were seated both 6 and 12 feet away from the talker loudspeaker. The noise level was kept at 55 dB SPL.
The speech was presented at 0° azimuth, and an equally distributed, continuous, speech-shaped noise was presented from four speakers surrounding the participant (45°, 135°, 225° and 315°).
The remote microphone was placed 6 inches from the talker loudspeaker.

Test conditions included:

1. *Unaided*
2. *Hearing aid only*
3. *Remote microphone streaming only*
4. *Remote microphone streaming plus hearing aid microphone*

The HINT SNR-50, or the signal-to-noise ratio required for correct repetition of 50% of the sentences, was recorded for all conditions. A one-way repeated measures analysis of variance was used to determine statistical significance of microphone condition.

Omnidirectional hearing aid microphone-only conditions for all four wireless transmission types did not significantly differ from each other.

The 2.4 GHz omnidirectional hearing aid-only setting significantly improved speech recognition in noise when compared to the unaided condition.

All four remote microphones streaming with the microphone-enabled hearing aid significantly improved speech recognition in noise when compared to both the unaided and the hearing-aid only conditions.

Performance with remote microphone plus hearing aid microphone decreased speech recognition in noise performance. The result was similar between the FM, Bluetooth and 900 MHz remote microphone but with the addition of the hearing aid microphone, the 2.4 GHz system was significantly poorer when compared to the other three systems. The source of this discrepancy was not revealed through electroacoustic verification.

Group performance at each distance (6 and 12 feet) showed that performance with all of the assessed remote microphones was not affected by increasing distance from the talker loudspeaker.

Improvement from all four remote microphone systems ranged from 6 to 16.8 dB across both seated positions and with and without the hearing aid microphones activated.

Conclusions:
The results of this study revealed that use of the remote microphone systems statistically improved speech recognition in noise relative to unaided and hearing aid-only conditions across all four wireless transmission protocols at 6 and 12' away from the talker.

This study was interesting because different wireless protocols were compared. Although there are some comments to make:

- *16 participants is a poor number of participants.*
- *Why they used both experienced users and non-users is not clear.*
- *The hearing aids and/or remote microphones used in this study are already replaced by more advanced systems.*
- *What would be the result of directional microphones activated in the hearing aids instead of the omnidirectional microphone setting?*
- *What would be the influence of venting in the earmoulds on the results of speech recognition in noise?*
- *The 2.4 GHz omnidirectional hearing aid-only setting significantly improved speech recognition in noise when compared to the unaided condition. There was no explanation for this finding.*
- *What's the cause of the poorer performance of the 2.4 GHz remote microphone plus hearing aid microphone setting when compared to the other three systems?*

Reasons enough to investigate more wireless protocols, which is not easy because there are many variables.

Cardiovascular risk factors and hearing loss: The HUNT study

Bo Engdahl, Aarhus L & Tambs K..

International Journal of Audiology 2015; Vol. 54, 958-966.

Hearing loss is caused by a variety of factors and a large chunk are genetic in nature. The cochlea is highly vascular and hence it is believed that any circulatory disease/disorder can affect the blood flow to the cochlea, causing permanent hearing loss. Several studies in the past have associated hearing loss with several cardiovascular risk factors, including hypertension, smoking, diabetes, being overweight, physical inactivity, cholesterol, triglycerides, resting heart rate, and unhealthy diet. A healthy lifestyle has been suggested as a preventive measure to protect against age-related hearing impairment.

In this large, general population sample of Norwegian adults (n=31547), they assessed the risk factors both prospectively 11 years before and simultaneously with the assessment of hearing. The aim of the study was to investigate the relationship between cardiovascular risk factors (smoking, alcohol use, physical inactivity, waist circumference, body mass index (BMI), resting heart rate, blood pressure, triglycerides, cholesterol, and diabetes) and hearing loss.

The subjects ranged in age from 20 to 101 years and the study was conducted in 2 phases. HUNT 1 and HUNT 2 included several types of examinations, including blood measures (BLM) and questionnaires. Air-conduction hearing threshold levels were obtained by pure-tone audiometry at eight frequencies from 0.25 to 8 kHz (low frequency 0.25 and 0.5 kHz, middle frequency 1 and 2 kHz, and high frequency 3, 6, and 8 kHz) for all the participants.

Multivariate linear regression analysis was administered on these huge data. Three models were obtained to control the covariate factors and make adjustments for other variables.

Except for systolic and diastolic blood pressure and triglycerides, there were statistically significant but weak associations with all cardiovascular risk factors. Estimates were generally in the hypothesised direction:

- *the effect of smoking, that was a positive association at high frequencies only, was maintained also after controlling for the other cardiovascular risk factors;*
- *higher levels of physical activity slightly decreased the level of hearing loss;*
- *diabetes increased hearing loss at high frequency;*
- *high waist circumference increased the level of hearing loss at the median frequency and also at high frequencies when controlling for other risk factors; and metabolic syndrome resulted in a hearing shift of about 1 dB at high frequencies.*
- *HDL cholesterol was negatively associated with hearing loss at all frequencies, an effect that was maintained after controlling for the other cardiovascular risk factors. Also LDL cholesterol and total serum cholesterol were negatively associated with hearing loss.*

However, the effects resulted in only a 1-3 dB hearing loss after correcting for several variables such as age, sex, level of education, income, recurrent ear infections, and noise exposure. The authors conclude that there is little to gain in increased hearing protection by reducing cardiovascular risk factors.

This is a prospective cross-sectional study with a large sample fairly representative of Norwegian population. The study examined a variety of cardiovascular risk factors over several years and looked for effects of each of them on changes in hearing thresholds. The study surely found effects of these risk factors on hearing loss but the effects were shown to be minute when compared to all previous studies.

Hearing-aid use and long-term health outcomes: Hearing handicap, mental health, social engagement, cognitive function, physical health, and mortality

Dawes P et al.

International Journal of Audiology 2015; Vol. 54:11, 838-844.

Hearing loss is a common phenomenon that is seen increasingly when the population ages. Effect of hearing aid use on health parameters has been studied widely in several parts of the world using observational studies, quasi-experimental studies, and randomised controlled trials. There is converging evidence from these studies that hearing aids reduce hearing handicap. There is limited and inconsistent evidence for the impact of hearing aids on mental health, physical health, cognitive function, and social engagement.

Moreover several studies published in the past have some limitations in controlling vital variables that may influence one or the other health parameters (mental health, physical health, cognitive function, and social engagement). Variables, such as not including the lower economic status, not ruling out the concurrent treatments for other handicaps, and not studying the effects on a long term impact, can still leave doubts in the minds of clinicians about applying these results in real life.

The objective of this study was to determine the association of hearing-aid use with a wide range of outcome measures in hearing impaired adults controlling for demographic differences between hearing-aid users and non-users. Outcome measures were on mental health, cognitive function, incident cognitive impairment, hearing handicap, social engagement, general health, and mortality assessed with five years and 11 years of follow-up. The hypothesis was that among hearing-impaired adults, hearing-aid use would be associated with better outcomes.

There were 2800 participants in the baseline examination (1998 – 2000), 2395 in 5-year (2003 – 2005), and 1812 in 11-year (2009 – 2010) examinations. Measures used were as follows: hearing handicap inventory for the elderly and adults – screening version (HHIE-S), mini mental state examination (MMSE), trail making test (TMT), digit symbol substitution test (DSST), auditory verbal learning test (AVLT), verbal fluency test (VFT), physical component score (PCS) from the SF-12 short form health survey, activities of daily living (ADL), instrumental activities of daily living (IADL) and the mental component score (MCS) from the SF-12..
Several statistical measures were applied to examine the effects on these parameters. At the five and 11 years follow-up, hearing-aids appear to reduce hearing disability among those with hearing impairment, although levels of self-reported hearing disability remain higher than for those with normal hearing. There were no significant differences in cognitive, physical health, social engagement, or mental health scores between hearing-aid status groups, adjusting for age, gender, and average hearing loss.

For hearing-aid users, self-reported hearing handicap was significantly lower for aided than unaided listening. However, aided scores still suggested clinically significant levels of hearing handicap. Hearing-aids were associated with reduced handicap, but that hearing-aid users were still likely to experience significant levels of handicap. In the present study, there were no differences in cognitive performance or the incidence of cognitive impairment between hearing-aid users and non-users. This is not supportive of a robust effect of hearing-aid use as being protective against cognitive decline. There were no significant differences in social engagement or perceived mental health between hearing-aid users and non-users.

The authors conclude that this is the best design possible (for ethical reasons) for this kind of study, and called for other studies to measure the effects of audiological variables.

This an observational-cohort study where a large sample of population was studied on over 10 objective parameters and for over 11 years. This strength can also be a weakness in that it is not an RCT study. But for an average reader of these studies, it is really confusing whether to include hearing-aid benefits beyond reduction in hearing handicap in our routine counselling or not.

The Influence of Hearing Aid Use on Outcomes of Children With Mild Hearing Loss.

Walker EA, et al.

Journal of Speech Language and Hearing Research. 2015; Vol. 58, 1611-1625.

Children with mild hearing loss (25-40 dB HL) are often difficult to be identified at an early age; even NHS protocols seem to miss this population. Lack of standardised test and intervention protocols seem to make it complicated for these children. Further, several studies of the past have shown mixed results on whether mild hearing loss has an effect on speech, language and academic performance. Limitations of these studies include grouping children with mild and unilateral hearing loss (HL) together under the umbrella term of minimal HL and/or failing to consider the contributions of early intervention, aided audibility, or consistent hearing aid (HA) use to outcomes.

Cumulative auditory experience—the culmination of audibility, HA use, and input over time—may moderate paediatric outcomes and is an issue that has rarely been described in the literature on children with mild HL. It is reasonable to assume that children with HL will demonstrate optimal outcomes if (a) they are identified, fitted with amplification, and enrolled in intervention early in development during a period of optimal neuroplasticity; (b) the HAs provide adequate access to the speech spectrum; and (c) the HAs are worn on a consistent basis.

This multi-centre study tried to find answers for three important gaps in our understanding and this study is linked to a larger study on outcomes related to children. In this study 38 children (age: 5 years10 months to 7 Years 2 months) who had a mild hearing loss in the better ear participated. Participants were divided into three groups on the basis of amount of daily HA use: (a) full-time users, (b) part-time users, and (c) non-users. The differences between groups (full time, part time, non-users) in maternal education level, nonverbal cognition, BEPTA, PEPTA, and aided and unaided SII were studied.

Tests administered apart from pure-tone audiometry were - The Goldman-Fristoe Test of Articulation–Second Edition (GFTA-2); The Peabody Picture Vocabulary Test–Fourth (PPVT-4); The Clinical Evaluation of Language Fundamentals–Fourth (CELF-4); The Comprehensive Test of Phonological Processing (CTOPP); Subtests from the Wechsler scales of intelligence, specifically the Block Design and Matrix Reasoning subtests; The Computer-Assisted Speech Perception Assessment (CASPA);

1. When do follow-up services (confirmation of HL, HA fitting, and early intervention) occur for children with mild HL as a function of NHS status?

The data of children identified and serviced at different timelines in their life shows that even NHS protocols identified only half these children and when they were identified but were confirmed very late about the hearing loss.

2. Are there differences in outcomes for children with mild HL as a function of amount of daily HA use?
The results showed that the full-time users had very large receptive vocabulary size (PPVT-4) when compared to non-users. The expressive morphosyntax (CELF-4) was significantly better between full-time and part-time users compared with the non-users. These results are shown clearly in the following table.

The study clearly shows that children with mild HL who wore HAs on a full-time basis would demonstrate higher scores on measures of language and speech perception ability and children with *little or no HA use would demonstrate lower performance (except for the articulation scores and speech perception in noise scores).*

3. The effect of cumulative auditory experience in children with mild HL on deeper aspects of language?
An analysis was conducted to determine whether cumulative auditory experience (age at confirmation, audibility, amount of HA use, and receipt of early intervention) influenced outcomes for children with mild HL. The outcome variables were CELF-4 Word Structure scaled scores and PPVT-4 standard scores. After controlling for age at confirmation, audibility, and early intervention, only amount of daily HA use shown to have an effect on both expressive morphosyntax and receptive vocabulary.

The authors concluded that these children are at risk for delays, particularly in areas such as morphology and phonological memory. Children with mild HL who do not utilise amplification are at risk for delays in vocabulary and grammar compared with other children with mild HL who wear their HAs regularly.

This multicentre study has focused in great detail on the challenges faced by children with mild hearing loss. The study employed a variety of measures and studied even deep aspects of language. The methods and statistics are applied very aptly to answer important questions.

Background Sounds and Hearing Aid Users: A Scoping Review.

Brian Gygi & Deborah Ann Hall.

International Journal of Audiology 2016; Vol.55 pag 1-10.

The scoping review represented in this paper focuses on background noise and the possible adverse effects it can have on hearing aid satisfaction and use. The review was conducted on publications written in the public domain about background sounds and adult hearing aid users, from the specific perspective of aversiveness, interference, annoyance, complaint. Background noise being any type of sound not the targeted focus of listening.

The scoping review followed a rigorous technique to summarise relevant literature. The objective being that of sorting out where the knowledge has been established, where findings are suggestive yet not definitive, where there are gaps in the existing body of knowledge, and where new research might be directed (cf. Arksey & O'Malley 2005).

The methods used for this scoping research were largely based upon the steps as per Arksey & O'Malley (2005) where (1) potentially relevant records were identified; (2) relevant records were selected; (3) data items were extracted; (4) the results were summarised, and reported; (5) and the final step being that of a thematic analysis to group the records according to their main findings relevant to the goal of this review.

For the identification of potential relevant records five search engines were used: PubMed, Web of Science, PsycINFO, CINAHL, and Google Scholar. The search was limited to the January 1st 1988 – January 31 2014 time frame.

For the subsequent selection of relevant records 377 duplicate records were excluded. A total of 560 records were excluded because they involved children, animals, cochlear implants, bone anchored hearing aids, drug trials. 8 records were excluded because the full text beyond their title was not available or not in English. At this stage of the selection process, 234 records were retained. After subsequent and scrupulous filtering process, five major themes were defined: (1) Outcome instruments; (2) general satisfaction; (3) hearing aid technology; (4) acclimatisation; (5) non-auditory influences.

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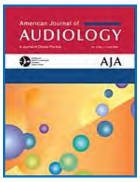
This interesting article covers one of the most important factors that can compromise satisfaction with hearing aids and that is background noise, yet interestingly highlights how there still exists a substantial knowledge gap on exactly what sort of background sounds are perceived as annoying or aversive. The paper suggests that future research should focus more on quantitative characteristics of background sounds which interfere with speech communication and or perceived as aversive. Another knowledge gap that seems to emerge from this carefully planned and well conducted literature research is the need to agree standards for assessing hearing aid benefit for listening in background noise and subjective perception of averseness or annoyance. Although the IOI–HA is regarded as an attempt to cover a core of domains, none of the seven items directly measures the effects of background noise and aided listening.

Arksey H. & O'Malley L. 2005. Scoping studies: Towards a methodological framework. Int J Soc Res Methodol, 8(1), 19–32

Clinician-Supported Internet-Delivered Psychological Treatment of Tinnitus



Gerhard Andersson.

American Journal of Audiology. Vol. 24 -3
September 2015 pag 299-301.

Tinnitus is still a challenge for health care systems across the world and arguably no cure as yet exists for even the most common forms of tinnitus. There is, all the same, some strong support for cognitive behavioural therapy (CBT) for counselling and psychological treatment. The first controlled study on guided ICBT for tinnitus distress was initiated in the late 1990s and subsequently published a few years later. This test had a substantial dropout rate from the study. The treatment consisted of a 6 week programme delivered with minimal support. Results are shown on diagram 1.

The second report included in this group was an open trial and it described how the treatment worked when implemented in the clinic. The study comprised 77 tinnitus patients and even in this case, at 30%, the dropout rate was substantial.

The third study was a controlled study comparing guided ICBT against a group treatment delivered in a clinic. 51 participants were included in the study with a lower dropout rate and the results on the main outcome TRQ showed no difference against group treatment.
Other studies retrieved in the 6 controlled studies mentioned in this paper (6 in which the treatment was compared against a control group and 3 in which internet treatment was compared against group treatment). 2 open studies based on clinical samples in regular care were also included the review. (Hedges's g=0.58).
For the 6 studies comparing internet treatment against a no treatment control condition, a moderate effect size was found.

This report of controlled studies on Internet Cognitive Behavioural Therapy for tinnitus indicates that the method is effective and probably as effective as face to face CBT. The challenges at the moment are represented by the small numbers of centres where the method has been tested hence the need for replications and further investigations.
The ICBT can be regarded as promising as an alternative to other standard forms of treatment delivery yet larger studies are needed.
One major obstacle is the lack of clinical psychologists working in audiological settings and audiologists trained in CBT (Baguely, Andersson, McFarran, & McKenna, 2013).

Baguley, D., Andersson, G., McFerran, D., & McKenna, L. (2013). Tinnitus: A multidisciplinary approach (2nd ed.). Chichester, United Kingdom: Wiley.

Is it necessary to occlude the ear in bone-conduction testing at 4 kHz, in order to prevent air-borne radiation affecting the results?

Maryanne Tate Maltby & David Gaszczyk.

International Journal of Audiology 2015; 54: 918–923.

Introduction
To most audiologists it has become common practice to occlude the test ear during bone-conduction measurements above 2 kHz to prevent the risk of audible air-borne radiation. Previous research has stated that the false air-bone gap is due to air-borne radiation from the oscillator. This article looks at whether in practice occluding the test ear is completely necessary.
When discussing an air-bone gap the authors are classifying a noticeable air-bone gap to be at least 10dB, this is aligned to the BSA masking criteria that, if there is an air-bone gap of 10dB or more, then masking should be applied. Previous research has shown that the average air-bone gap at 4kHz is between 12.2 dB and 13.4 dB for people with sensorineural hearing loss and 5.6 dB for those with normal hearing. Previous research has recommended that the ear under test should be occluded at 3kHz and 4kHz to prevent erroneous results.
However the authors put forward an argument that occluding the ear may be uncomfortable for the patient and increase phantom sounds and the perception of any tinnitus.

Method
To reduce bias, the authors carried out all tests on 44 subjects (52 ears were finally included) using the same audiologist using one of two calibrated audiometers. This is important as inter-tester differences are larger with bone-conduction testing over air-conduction testing. The inclusion criteria required that audiograms show no greater than a 5 dB difference between AC and BC at 0.5 to 3 kHz, but >10 dB air-bone gap at 4 kHz. 4 kHz was selected as this is where the greatest air-borne radiation occurs. The test for BC at 4 kHz was repeated under three conditions: open ear, covered by earphone and covered by soft foam earplug.

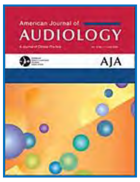
Results
The results of the study show no difference between the conditions of open ear and test ear occluded with an earphone. When the test ear was compared in the open ear condition and occluded by an earplug, there was no significant difference, the difference being two instances of 5 dB. The suggestion that the test ear should be occluded at frequencies above 3 kHz is not supported by the results of this study. The errors that result in the false air-bone gap would not appear to be due to air-borne radiation as supported by evidence referenced by the authors in this article.

Conclusion
The authors conclude that occluding the test ear during the bone conduction procedure in pure-tone audiometry should be reconsidered and discontinued.

Evidence based clinical practice should be based on thorough research. Sometimes procedures that have been used for many years may need to be verified again.
This is a typical case of a practice that may have had its use at some point, but based on this study it turns out to be at least something worth critically reviewing.

The graph under is self-explaining ;-)

Can a Remotely Delivered Auditory Training Program Improve Speech-in-Noise Understanding?



Harvey B. Abrams, Kirsten Bock & Ryan L. Irey.

American Journal of Audiology. Vol. 24 -3
September 2015, 333-337.

Research has supported the benefits of auditory training on speech perception, but despite this potential benefit, only 16% of audiologists report providing such services to their patients. The goal of remotely delivered computerised auditory training is to provide post-fitting care that is effective, convenient and accessible.

In this study, one currently available programme (ReadmyQuips, RMQ) was used by 15 of 29 participants with no hearing aid experience or use in the previous 12 months.

Two tests (The Hearing in Noise Test, HINT, and the Words-in-Noise test, WIN) were completed at visit 2 (baseline + 1 week) and at visit 3 (baseline + 4 weeks). At visit 2, the Auditory Training (AT) group was trained on accessing and using RMQ, and they were instructed to use this program on their home computer while wearing their hearing aids for 30 min each day, 5 days a week for the coming 3 weeks.

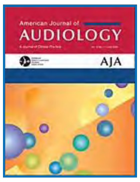
The results show no significant improvement in the speech-in-noise understanding.
The number of hours spent on AT influenced the results of the WIN test, but not the results of the HINT test.

A possible explanation for the lack of improvement is that the participants did not spend enough hours training (they were instructed to use it for 7.5 hours, but the mean hours of use was under 4 hours).

The authors suggest further research to examine the programme's effectiveness in improving audiovisual performance and increasing hearing aid wear time. They noticed that the AT group demonstrated little reduction in their daily hearing aid use time as compared with those in the control group whose mean daily hearing aid use time decreased by more than an hour. This difference was not statistically significant.

If participants of a study cannot be motivated to use a programme like this, it won't be used by the daily client of hearing care centre. The fact that there was no decrease in hours of use by the AT group could have been caused by the fact that the AT group was more aware that you need to (and train to) get used to the aided sound.

A Comparison of Two Methods for Measuring Listening Effort As Part of an Audiologic Test Battery.



Jani Johnson, Jingjing Xu, Robyn Cox & Paul Pendergraft.

American Journal of Audiology. 2015, Vol 244, 419–431.

Speech understanding is a complex task involving use of peripheral hearing and involvement of higher-level auditory and cognitive processes. Although speech understanding might be maintained in difficult listening conditions, if the speech signal becomes degraded and/or there is an auditory processing deficit, this can result in an increase in reported effort to understand speech. It is generally presumed that this reported effort is a result of the increased mental or cognitive effort needed for speech comprehension under difficult conditions and is often referred to as "listening effort".

Previous research has shown that reported listening effort and measured speech intelligibility are separate hearing aid outcome domains meaning that listening effort should not be inferred from speech intelligibility scores. This research compared results from a self-report measure of listening effort by use of a rating scale and from a listening effort measure of performance on a word recall task using a dual-task paradigm under varying levels of listening demand. The relationship between the two measures was examined for their validity, sensitivity and effect on speech intelligibility performance to determine which measure would be most suitable for inclusion in a comprehensive audiological protocol.

Self-report measures of listening effort are made by asking listeners to respond to a question about how much effort is required to complete a listening task; subjectivity is a possible disadvantage of such a self-report measure. Word recall performance measures are made by asking listeners to respond to word lists or sentences and to retain key words in memory for periodic recall of key words. The hypothesis is that, in more difficult listening environments, more cognitive resources must be allocated to the speech intelligibility task, leaving fewer resources for the word recall task. Therefore, recalling fewer key words is interpreted as reflecting increased listening effort.

In this study, the two selected measurement methods were compared to evaluate which was most effective for assessing listening effort while simultaneously assessing speech intelligibility. The intention was to answer four questions:-

1. *Is speech intelligibility score independent of the measure of listening effort?*
2. *Do self-reported ratings and word recall measures of listening effort provide the same information?*
3. *Are both methods valid measures of listening effort?*
4. *Which method is more sensitive to changes in listening difficulty presumed to affect listening effort?*

Methods

Thirty adults were selected with a self-rated hearing difficulty of none or mild with ages ranging from 23 to 39 years (M = 26.6, SD = 4.8). There were 9 male and 21 female participants. Participants with no more than mild self-reported hearing problems were selected to allow for evaluation of the listening effort measures while avoiding issues related to differences in audibility. Research has shown that mental exertion in difficult listening conditions occurs for normally hearing and hearing impaired people.

Speech intelligibility performance was evaluated at four signal-to-noise ratios by using keywords embedded in both high-predictability (HP) context and a low-predictability (LP) context sentences. Listening effort was evaluated at set intervals throughout the speech intelligibility task. It was expected that speech intelligibility scores would be higher for the HP key words and for each successively easier SNR condition. The Revised Speech Perception in Noise Test (R-SPIN) was used for this study.

For the self-report rating of listening effort (RAT), participants used a seven-point scale to rate how much effort it took for them to complete each list of R-SPIN sentences. For the word recall method of measuring listening effort (REC), participants were required to repeat groups of response words from the R-SPIN test. One reason for selecting the RAT and the REC methods of measuring listening effort for evaluation in this study was that both measures allow for simultaneous assessment of speech intelligibility and listening effort and are potentially efficient for inclusion in an audiological assessment protocol.

Results

The results obtained with the two measures were consistent with expected changes in listening effort. However, data obtained with the self-report method (RAT) demonstrated greater sensitivity to these changes, supporting a conclusion that the self-report measure (RAT) was preferable for measuring listening effort simultaneously with speech intelligibility.

A summary of the answers to the four questions which this research addressed are:-

1. Is Speech Intelligibility Score Independent of the Measure of Listening Effort?

Substantial differences in speech intelligibility scores for the two listening effort measures would suggest that speech intelligibility data were affected by the listening effort measure.

2. Do Self-Reported Ratings and Word Recall Measures of Listening Effort Provide the Same Information?

The study showed low correlation results between the two methods as indicating that the two measures did not provide equivalent information with regard to listening effort.

3. Are Both Methods Valid Measures of Listening Effort?

A valid measure of listening effort should be sensitive to changes in the degree of mental exertion required in varying listening conditions. It would be expected that a measure of listening effort would reflect more effort (higher ratings or fewer words recalled) at more difficult SNRs and with lower context sentences.

a) Self-Reported Rating (RAT): Figure 3 shows the average self-report rating of listening effort as a function of SNR, when tested by using HP and LP sentences. As predicted, participants reported greater listening effort on average as SNR became more difficult and for sentences with lower-predictability. Further, it can be seen that the differences in self-reported effort between HP and LP sentences were greater at easier SNRs.

b) Word Recall Method (REC): Figure 4 shows the average number of words correctly recalled as a function of SNR, for HP and LP sentences. It can be observed that mean word recall performance improved slightly with increasing SNR. Also, at the three easiest SNRs, word recall performance was slightly better for HP words.

4. Which Method Is More Sensitive to Changes in Listening Conditions That Are Presumed to Affect Listening Effort?

The data from this study showed that the RAT method reflected primarily large effects as listening demand varied across contexts and adjacent SNRs, whereas data from the REC method demonstrated primarily small effects. This finding suggests that the RAT method was more sensitive to changes in listening difficulty presumed to affect listening effort.

Conclusion

A well written and very readable article. This research adds to the listening effort literature and is the first study that has included an evaluation of the comparative effect of different listening effort measures on speech intelligibility performance as a way to determine the methods' suitability for use in a comprehensive set of audiological outcome measures. Although the authors justified the inclusion only of normally hearing participants, a comparable but larger study involving hearing impaired participants would be welcome especially if it included effects of participants' cognitive abilities.

Evaluation of a BICROS System with a Directional Microphone in the Receiver and Transmitter

Michael Valente & Kristi Oeding

Journal of the American Academy of Audiology. 26: 856–871 (2015)

The aims of this study were to examine four experimental questions:

1. *Are there significant differences for sentence recognition in noise using HINT sentences between the OM (omnidirectional microphone) and DM (directional microphone) in the Tx (transmitter)*
   a. *when speech is presented 90° to the Rx (receiver) and noise from 0°, 180°, and 270° to the Tx (Sp Rx/N Tx)?*
   b. *when speech is presented 90° to the Tx and noise from 0°, 180°, and 270° to the Rx (Sp Tx/N Rx)?*
   c. *in a diffuse listening condition (speech from 0° and noise from eight surrounding loudspeakers separated by 45°)?*
2. *Are there significant differences in subjective preferences between the OM and DM microphone conditions in the Tx using the APHAB?*

Study Design and Methods

Recruitment for this study resulted in 18 participants. Inclusion criteria included the following: the participants (a) must have worn a BICROS system for at least four weeks, (b) have ASNHL, (c) should be at least 18 years of age, and (d) should be a native English speaker.

The Widex Dream 440 Fusion receiver-in-the-canal (RIC) was the Rx hearing aid and the Widex contralateral routing of signals (CROS) thin-tube behind-the-ear (BTE) hearing aid was the Tx used in the study. All settings (noise reduction, impulse noise, etc.) remained at manufacturer default settings. The fit of the BICROS system was verified using real-ear insertion gain (REIG) measures. The National Acoustic Laboratories' Nonlinear version 1 prescriptive target (NAL-NL1; Byrne et al,2001) was corrected for channel summation (15 channels).
The participants were blinded to which microphone condition in the Tx was being evaluated. Half of the participants began with the OM and the other half began with the DM.
HINT sentences were used for sentence recognition in noise with uncorrelated Lou Malnati's restaurant noise at 65 dBA. The aided APHAB questionnaire was administered to examine the respective microphone condition (OM and DM).

Results and Discussion

When examining sentence recognition in noise, the results revealed no significant differences between the OM and the adaptive broadband DM in the Tx for the Sp Rx/N Tx condition. The DM performed significantly poorer (1.9 dB) than the OM for the Sp Tx/N Rx listening condition. The DM, however, provided significantly greater benefit of 2.6 dB relative to the performance of the OM in the Tx in a diffuse listening condition (figure 5). When examining subjective preferences, the results revealed no significant differences in subjective preferences/performance reported between the OM and DM in the Tx using the APHAB (figure 6).

To further examine why the OM provided an advantage in RTS (reception threshold for sentences) compared to the DM, the authors measured the polar plot of the OM and DM with the Frye 8120 (figure 7). The directivity index reduces as the input level increased. This may be related to reduction of the output from the DM due to output limiting, compression and noise reduction characteristics within the 15 bands in the BICROS system.

Datalogging was examined and showed that participants preferring OM spend more time in 'quiet place with speech' and no time in 'noisy place with speech' and less than other participants in 'noisy place' or 'very loud noise'.

Conclusions

One of the major findings in this study was that in diffuse listening condition the DM in the Tx provided 2,6 dB advantage.
APHAP examined overall performance with DM and OM and showed no significant difference. It seems that examining discrete moments could give more information on when participants prefer DM and when the prefer OM.

References

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Oeding K, Valente M. (2013) Sentence recognition in noise and perceived benefit of noise reduction on the receiver and transmitter sides of a BICROS hearing aid. J Am Acad Audiol 24(10):980–991.

Kuk F, Korhonen P, Crose B, Lau C. (2014) CROS your heart: renewed hope for people with asymmetric hearing losses. Hear Rev 21(6):24–28.

This article increases our understanding of the advantages and disadvantages of the Widex BICROS system fitted with DM or OM. The Widex BICROS system only allows an automatic program with the Tx activated. In all other (max 5) programs the Tx is switched off. The on-off button is handy, but sometimes participants forget to turn it on. It could be better if it is turned on once the battery door is closed. The volume control is seen as a positive innovation though not all participants used it. Electromagnetic interference with the 10,6 MHz wireless communication and some telephones is a problem to be solved. Problems with static noise being 6-14dB higher with de Tx switched on could be partly due to NAL-NL1. In the future, first-fit rules could be examined.
An automatic adaptive multichannel DM in the Tx should be examined in dynamic listening environments. Patients should be able to switch to an OM program if speech is on the Tx side.

As noted in this study counselling is very important on the use and care of the hearing device (even for experienced users) and scheduling patients for a greater number of visits should be considered after a new hearing aid is dispensed. Patients should be trained to use volume control, on/off button and programs to get the maximum result in different listening situations as the limitations of hearing with one ear, even with BICROS, still present a challenge. .