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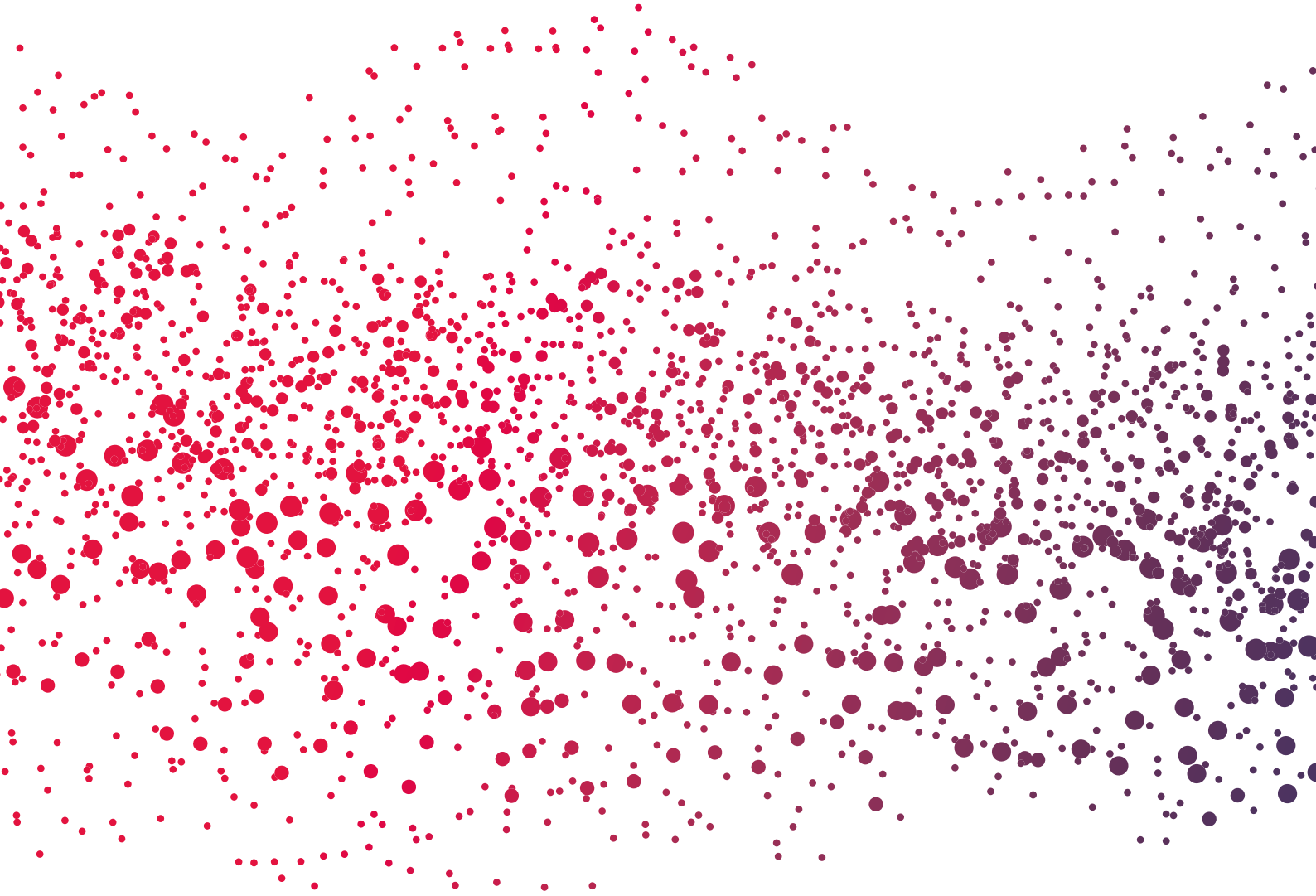
Otology & Audiology Article Review



JANUARY 2014

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- A Brief Overview of Factors Affecting Speech Intelligibility of People With Hearing Loss: Implications for Amplification
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  - *American Journal of Audiology Vol. 22; 306–309 (Dec 2013).*
  - *A short article which aims to determine the predictability of speech intelligibility from audibility and other factors for people with different degrees of hearing loss.*
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  - *Andrea L. Pittman, Mollie M. Hiipakka.*
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- Acceptable noise level (ANL) and real-world hearing-aid success in Taiwanese listeners.
  - *Hsu-Chueh Ho, Yu-Hsiang Wu, Shih-Hsuan Hsiao & Xuyang Zhang.*
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  - *The current study suggested the possibility of using ANL to predict hearing-aid success. However, this study shows that the usefulness of ANL as a clinical tool is unlikely to be as great as indicated by the literature.*
- Laboratory and Field Study of the Potential Benefits of Pinna Cue-Preserving Hearing Aids.
  - *Niels Søgaard Jensen, Tobias Neher, Søren Laugesen, René Burmand Johannesson and Louise Kragelund.*
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  - *In a population of 17 subjects with mild to moderate sensorineural hearing loss, the potential benefits of an experimental hearing aid with a microphone position that preserves high frequency spectral cues of the pinna was compared with the same hearing aid with a microphone position that did not preserve these cues.*
- Acceptable Noise Levels in Preschool Children withNormal Hearing.
  - *Melinda Freyaldenhoven Bryan, Clifford Franklin, Krystal Sullivan Ware, Rachel Horne.*
  - *J Am Acad Audiol 24:823–831 (2013)*
  - *Determine if ANLs could be obtained in preschool children, aged 4 and 5 years, Results show that all the 5 year olds completed the task successfully and showed a good test-retest reliability, whereas less than half of the 4 year olds performed the ANL task succesfully. The distribution of mean ANLs, SDs and range that could be obtained in this study agree with those collected from 8 and 12 year old children and adults.*
- Modern Prescription Theory and Application: Realistic Expectations for Speech Recognition With Hearing Aids.
  - *Earl E. Johnson.*
  - *Trends in Amplification (Dec 2013) 17(3/4) 143–170.*
  - *On group level, NAL-NL2 seems to be the most efficient and gain-economic choice … but individuals with less desensitization than normal may not receive enough gain for high frequencies as they would get using the DSL m(i/o) rule.*

Exploring the Limits of Frequency Lowering

Souza, P. E et al.

Journal of Speech, Language and Hearing Research.2013,Vol 56: 1349- 1363.

Frequency shifting technologies, to assist hearing aid users with the limitations of amplification in the higher pitches, is a relatively new development. The need for this type of technology is evident from the lack of intelligibility from traditionally-aided high frequency losses. Although there have been a number of research papers on the effect of frequency lowering on severe – profound cases, there has been a lack of similar research directed towards milder hearing losses, apart from one study combining both adult and paediatric subjects.

The purpose of this study was to assess how frequency lowering, or more specifically, frequency transposition, affected both speech intelligibility and quality. The study was performed using adults with fluent English and mild – moderate high frequency hearing losses.

26 subjects were used with moderate high frequency losses aged 62-92. Five of these were hearing aid wearers, none of whom utilised frequency lowering technology. A further 14 control subjects were used with normal hearing up to 4 kHz. Six signal-to-noise ratios (six person babble) were used with each presented sentence, including five SNRs from -10 to 10 dB in a quiet environment.
For speech intelligibility testing, 1 of 660 recorded, low context sentences (varying SNR) were presented through a headset within a sound proof booth by a female speaker at 65dB SPL. Each subject was asked to repeat the sentence for accuracy. Three cut off frequencies (1, 1.5 & 2 kHz) were tested with all subjects using 50 sentences for each.
Under identical criteria, 2 specific sentences were used to test speech quality. The subjects were asked to subjectively rate the recordings (rating range 0-10) presented with a random SNR.

SNR significantly affected results, with range of intelligibility and quality responses spanning from zero to almost 100%, with the hearing impaired group scoring consistently poorer than the control group. The data suggest no significant positive effect on intelligibility or quality, but demonstrated deleterious effects when low cut off frequencies were coupled with high compression ratios.

The authors suggest that individual data be examined on a trade off basis between audibility and distortion. If audibility is not an issue (i.e. mild high frequency thresholds) then the distortion from frequency lowering would reduce intelligibility. For higher degrees of loss the distortion is outweighed by the increased audibility of the higher frequency range.

Quality ratings were highly dependent on intelligibility scores with a much wider range of ratings with good intelligibility.

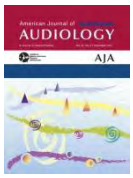
This study confirms current practice in frequency lowering for high frequency severe-profound losses, but also suggests that this technique could be beneficial for others with milder losses (60 dB HL and higher).

Although the authors entitled the article 'Frequency Lowering', the study was confined to transposition. Many of the articles, used to develop the current study, were directed at frequency compression research and so may not have been the most appropriate to use. One of the biggest concerns, not mentioned in the study, was the effects of open fit technology frequently used for mild to moderate losses, and how this would more than likely lead to conflicting signals being processed.

Control subjects were selected on the basis of normal hearing up to 4 kHz, but this does not omit individuals with ski slope losses after this point. These data were not included.

A Brief Overview of Factors Affecting Speech Intelligibility of People with Hearing Loss – Implications for Amplification

Teresa Y.C. Ching& Harvey Dillon



American Journal of Audiology. 22:306-309, December 2013.

It is well known that that people with hearing loss have more difficulty understanding speech than those with normal hearing, especially in difficult listening conditions. This article gives an overview of the factors which reduce speech intelligibility and then briefly describes a study intended to predict speech intelligibility based on audibility, psychoacoustic abilities, cognitive ability and age.

The authors describe four causes of difficulty in understanding speech, namely:-

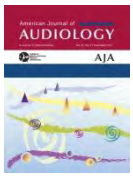
- ***Reduced Audibility*** *– When speech isn't heard, it cannot be understood. The Speech Intelligibility Index (SII) can be used to assess the effect of speech audibility on intelligibility (ANSI 1997). However, most studies have shown that speech intelligibility was worse than would be predicted by the SII especially for severe hearing losses. The authors concluded that other factors than audibility must contribute to the difficulties experienced by hearing impaired people.*
- ***Reduced Frequency Selectivity*** *– This refers to the ability of the cochlea to resolve the spectral components of complex sounds. It has long been established that cochlear hearing loss results in broader auditory filters which reduce the spectral shape of speech sounds and limit the ability to separate speech components from background noise.*
- ***Dead Regions*** *– These are areas of the cochlea with no inner hair cells and/or neurones to transduce basilar membrane vibration. Sounds at the characteristic frequency of a dead region are detected in other parts of the cochlea. Those with dead regions in the cochlea may extract little or no information from speech components whose frequencies fall within a dead region even when amplification makes them audible. Findings from studies on the effect of cochlear dead regions on speech intelligibility are not conclusive.*
- ***Reduced Cognitive Ability*** *– Cognitive functions which relate to speech intelligibility include attention, memory and use of contextual information. Separating speech sounds from competing noise involves complex cognitive functions. Studies confirm the link between speech scores and cognition but cognitive ability appears to have a lesser effect than hearing thresholds.*

This article then briefly describes a recent study which investigated the relationship between speech recognition deficits and the psychoacoustic and cognitive abilities of those with hearing loss. This study involved 75 adults between 20 and 86 years of age with hearing thresholds ranging from average normal to profound hearing loss. From speech in noise tests, not surprisingly those with hearing loss extracted less speech information. These subjects were also assessed for outer hair call function (oto-acoustic emissions), frequency resolution (TEN test) and working memory (visual digit-monitoring task). After allowing for the effects of hearing thresholds and associated impoverished frequency resolution, the only notable predictors of speech intelligibility were cognitive ability and age.

Conclusions were that hearing threshold level is critical for prescribing amplification but that adjustment for cognitive ability and age is not necessary. Although cognitive ability and age adversely affect speech intelligibility, their effects do not vary with frequency.

An interesting article but it does not add much to our knowledge about the parameters, other than audiometric hearing thresholds, which would improve predictions of speech intelligibility after allowing for the effects of hearing loss. A more detailed article on the same subject and by the same authors is apparently in preparation for the Journal of the Acoustical Society of America.

Evidence-Based Practice in Audiology: Rehabilitation Options for Adults with Hearing Impairment



Louise Hickson, Ariane Laplante-Levésque & Lena Wong

American Journal of Audiology. 22:329-331, December 2013.

The introduction to this article provides a succinct explanation about evidence-based practice (EBP) in a clinical setting which acknowledges the three key elements of EBP:-

- *The research evidence*
- *The client's preferences and goals*
- *The clinician's or practitioner's expertise*

The context of EBP influences the information and options discussed between client and clinician/practitioner and the context for this article is adults with hearing loss. This article addresses three questions relevant to this context:-

- *Why is EBP important for hearing impaired adults?*
- *What is the evidence about intervention options for adults who are identified as having hearing impairment?*
- *What interventions to adults choose when they are identified as being hearing impaired for the first time?*

Importantly, the authors show that EBP supports the offer of intervention options beyond just a focus on the fitting of hearing aids.

The authors devote the rest of the article to coverage of the five steps in the EBP process:-

1. ***Defining a Clinical Question*** *– In our context of adults with hearing loss, the clinical question relates to auditory rehabilitation. Following diagnosis of a hearing impairment, the key question is whether intervention in the form of hearing aids with a communication or rehabilitation programme will achieve the desired outcomes of reduced activity limitations and participation restrictions compared to no intervention?*
2. ***Searching for Research Evidence*** *– The next step is to look for evidence which addresses the clinical question and there are suggestions about where to look for such evidence and for published reviews of the evidence.*
3. ***Evaluating the Evidence*** *– Using two published systematic reviews of evidence about hearing aids and about communication or auditory rehabilitation programmes, a positive conclusion is reached. As a summary, the answer to the above clinical question is that the intervention of hearing aids with a communication/rehabilitation can and does achieve the above desired outcomes.*
4. ***Relating the Evidence to the Client*** *–Based on the evidence, adults who have been identified for the first time as having a hearing loss can be told that hearing aids and communication/rehabilitation programmes are likely to be suitable interventions. This may be helped by "decision aids" which assist clients in making informed decisions and help the clinician/practitioner in advising a client about their options. Such "decision aids" are part of the process of shared decision making. A study is briefly described in which a decision aid was used to support the offer of hearing aids or a communication programme or no intervention to 153 adults. The results are shown in Figure 1 below. The study found that the participants were very receptive to being involved in the decision making process.*
5. ***Evaluating Outcomes of EBP*** *– The final step in EBP is reflection on the process and the outcomes in relation to the original clinical question. This article concludes that EBP is important for adults with hearing loss as it creates a meaningful process which connects the clinician/practitioner and the client with research. With the so much literature about intervention options for hearing impaired adults, it is clear that evidence should inform practice. This ensures that the cost-benefit attributes of different intervention options are properly considered before any decision about which option to take.*

This short article gives an excellent summary of the principles of evidence-based practice in adult audiology with a very useful list of recent references enabling the subject to be explored in more depth. This article ends with a clear and meaningful statement about its purpose:- ***"EBP is frequently talked about as a gold standard in audiology practice. The time has come to make it a reality"***

Hearing Impaired Children's Preference for, and Performance with, Four Combinations of Directional Microphone and Digital Noise Reduction Technology

Pittman, Andrea L.; Hiipakka, Mollie M.

Journal of the American Academy of Audiology. 24:832-844 (2013).

Fifteen children, between the ages of 8 and 12 years, were fitted with hearing aids (GN ReSound Alera IX) having four memories that contained different combinations of digital noise reduction (on, off) and directional microphones (omnidirectional, directional). Speech stimuli were presented from one of two positions (front, back) in two noise conditions (steady-state-noise, multitalker babble). As expected, performance decreased in the directional microphone conditions when the speech originated from behind the child. In all other conditions, performance was equally good. The most important finding is the agreement between the children's preference for noise-management features and their speech perception. This study also showed that the children preferred one or two noise-management features in each of the listening conditions. Finally, there were indications that the children preferred noise management that maximized listening comfort (e.g. preference for DNR in the multitalker babble conditions even though this feature is not designed for those environments).

The weakness of this study lies in the small number of participants and the short period of testing (final preference was scored approximately 30 minutes after the initial preference). It is dearly not possible to extrapolate these results to predict children's long-term acclimatisation. Also note that the hearing aids (only GN ReSound Alera IX behind-the-ear) were programmed with DNR 'strong' and fixed directionality with the directional mix set to 'high' and venting of the earmoulds was not verified. The results of the present study suggest though that children may benefit significantly from noise-management features in adverse listening environments and that they are capable of judging the listening environment and choosing appropriate noise management.

Acceptable noise level (ANL) and real-world hearing-aid success in Taiwanese listeners

Hsu-Chueh Ho; Yu-Hsiang Wu; Shih-Hsuan Hsiao; Xuyang Zhang

International Journal of Audiology 2013; 52: 762-770

ANLs were measured using two different speech materials: Taiwanese and a non-semantic speech signal (the International Speech Test Signal (ISTS)) for 80 hearing-impaired adults to investigate the relationship between ANL obtained pre-fitting and hearing-aid success three months post-fitting. Hearing-aid success was assessed using the Chinese version of the IOI-HA and, in order to investigate if the results of the study by Nabelek et al (2006) could be replicated, using the Chinese translation of the hearing-aid use questionnaire (Nabelek et al, 2006).

The mean Taiwanese ANL (11,6 dB) was very close to the mean ISTS-ANL (10,5 dB). Both the Taiwanese and ISTS-ANL were associated with real-world hearing-aid success, regardless of whether the success was assessed using the IOI-HA or HA Use questionnaire. However, although the association was statistically significant, the accuracy for ANL to predict the probability of hearing-aid success was much lower than that suggested by Nabelek et al (2006).

The first limitation of this study is the fact that ANL was measured only once. If ANL could be measured multiple times and then averaged, the association between ANL and hearing-aid success would be better established, because the ANL-difference between successful and unsuccessful users was relatively small (≈3 dB). Secondly it has been shown that hearing-aid outcome is dependent on culture and education level, so the results of this study may not be generalised to listeners from different countries and cultures. Thirdly the choice of hearing-aid model, style, features, and bilateral/unilateral fitting was not controlled in this study.

Laboratory and Field Study of the Potential Benefits of Pinna Cue-Preserving Hearing Aids.

Niels Søgaard Jensen et al..

Trends in Amplification Nov. 2013Vol 17, 171–188.

In a population of 17 subjects with mild to moderate sensorineural hearing loss the potential benefits of an experimental hearing aid with a microphone position that preserves high frequency spectral cues of the pinna was compared with the same hearing aid with a microphone position that did not preserve these cues.

Localisation test showed:-

- *a significant mean reduction of 22° in the root mean square (RMS) error in the front–back ratio for the pinna-cue-preserving setting*
- *no significant mean difference in RMS error in the left-right dimensions between settings.*

Spatial-unmasking test conditions showed no significant differences between settings (in contrast to the real-life benefit reported by 12 of the 17 subjects related to speech intelligibility and sound quality).
Questionnaires (SSQ & SSQ-C) showed:-

- *small non-significant benefit of the pinna-cue-preserving setting in certain real-life situations*
- *no significant real-life localisation benefit of the pinna-cue preserving setting. There was no correspondence between the CIC localisation benefit obtained in the laboratory and the reported real-life experience.*
- *the overall trend in the preference ratings was a preference for the pinna-cue preserving configuration. Most commonly mentioned reasons were related to speech intelligibility (in noise or in groups) and sound quality.*

According to the authors, implications of the results for clinical HA fittings are that the pinna cue-preserving experimental hearing aids at best will benefit some users in specific real-life situations and that they do not significantly disadvantage anyone.
This is a nice study showing some of the potential benefits and restrictions of pinna cue-preserving hearing aids. Both real-life performances and laboratory tests are included, showing that real-life performances (localisation and spatial release from masking) of different microphone settings can be quite inconsistent with laboratory results. The hearing aid fitter should read all results because the 'clinical implications for HA fittings' mentioned by the authors are probably not the best summary to take away..

Acceptable Noise Levels in Preschool Children with Normal Hearing

Melinda Freyaldenhoven Bryan et al.

J. Am. Acad. Audiol.24:823–831 (2013)

Twenty-three children, ages 4 years (N=14) and 5 years (N=9) with normal hearing undertook the ANL test. Purpose of this study:

1st: Investigate the reliability and the distribution of the ANL

2nd: Measure the effect of background noise

Results show that less than half of the 4 year old performed the ANL task successfully whereas all the 5 year olds performed the test with success. The results show good test-retest reliability. Therefore ANL can reliably be obtained in 5 year old children. The effect of background noise is comparable with the results in older children and adults.

In this investigation, the age limit for testing ANL in children is limited to the age of 5. More research in a larger population is required. Apart from hearing screening, no information about the cognitive or behavioural functioning of these children is obtained in this study. Possibly other factors (for example ADD) influence the ability to perform the ANL test. Another question is: What would be the purpose of conducting the ANL test in children? Will ANL test result provide us with the information we need?

Modern Prescription Theory and Application: Realistic Expectations for Speech Recognition With Hearing Aids.

Earl E. Johnson.

Trends in Amplification, Dec 2013,17(3/4) 143–170.

In modern hearing aid fittings, we have the possibility to provide more functional gain in frequencies higher than 3 KHz. On the other hand, the aim to give the maximal possible amplification can be in contradiction to a better speech perception for hearing losses in combination with desensitisation, wherein amplification can provoke excessive loudness without better results in Speech In Quiet tests.

This article compares the prescription gain of the two best known prescription rules (NAL-NL2 and DSL m(i/o)) in two groups of hearing impaired subjects: Children of 36 months and adults.
Each prescription rule has its own approach on amplification. NAL-NL2 has the aim not to exceed the perceived loudness of a listener with normal hearing sensitivity and prescribes audibility, useful to speech recognition, while DSL m(i/o) has the aim to maximise bandwidth to get access to all cues that can possibly improve speech recognition.

In practice DSL m(i/o) prescribes a lot more gain in the higher frequencies which will lead to more audibility for high frequencies but the perceived loudness may be too high. NAL-NL2 uses a cut-off frequency to avoid excessive loudness in subjects with high frequency desensitisation and very efficient correction of the speech intelligibility index (SII). So on group level, NAL-NL2 seems to be the most efficient and gain-economic choice … but individuals with less desensitisation than normal may not receive enough gain for high frequencies as they would get using the DSL m(i/o) rule.

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