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Revue canadienne d'audition

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Can Acceptable Noise Levels Be Predicted from a Noise-Tolerance Questionnaire?

Peer Reviewed

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As Charles Dickens wrote in *The Tale of Two Cities* in the 19th century, "These are the best of columns; these are the worst of columns … well, actually he never wrote that, but if he would have read the columns in this issue of the *Canadian Hearing Report* I am sure that he would have been impressed and would have re-titled his famous book *A Tale of a Whole Bunch of Great Columns*. Not quite as catchy but at least nobody gets beheaded during the French revolution.

In this issue we see the introduction of some new columns, in addition to some oldies. Gael Hannan is a consumer advocate for people living with hearing loss. She works with hearing-related organizations to raise awareness of hearing loss issues, and has delivered her signature presentations *EarRage!* and *Unheard Voices* to audiences across North America and New Zealand. Gael is currently a director on the national board of the Canadian Hard of Hearing Association (CHHA). Her column, "From the Consumer" says it all and Gael starts with a resounding call for cooperation between the consumer and the hearing health care professional.

Another new column, "All Things Central" is about all things central, at least as far as central auditory processing disorders are concerned. The column is written by Dr. Kim Tillery, PhD. She is a professor in and chairperson of the Department of Communication Disorders and Sciences at the State University of New York at Fredonia and also has a private practice in diagnosing and treating individuals with (C)APD. Kim has presented over 90 workshops and presentations at national, international and regional conferences, and has authored and co-authored several book chapters and journal articles on (C)APD.

And why stop there? Calvin Staples is well known for his work on the analysis and inherent variability of first fit algorithms for hearing aids. He is currently an instructor at Conestoga College in Kitchener and is also a world-class long distance runner. Calvin has agreed to select several blog entries for every issue of the *Canadian Hearing Report* from www.hearinghealthmatters.org. A group of well-known audiologists and other hearing health care professionals have formed this blog. Calvin will be selecting some of the more interesting entries and these will be reprinted with permission in our old fashioned print publication – how's that for retro?

And speaking of retro, it's time to dust off our old books. A semi-regular column (and with your input, perhaps a regular one) called "From the Dusty Bookshelves" makes its debuts in this issue. Recently Dr. Richard Seewald gave me the honour of having a first kick at the can for acquiring his old books when he was recently cleaning out his office at the University of Western Ontario. I've been spending far too much time reading some really amazing publications from the 1940s, 1950s and 1960s – many of which are now out of print. I thought it appropriate to review one of these old books. Quite frankly, if we don't then who will and they will be lost to oblivion. For this issue of From the Dusty Bookshelves, I have done a review of *Forty Germinal Papers in Human Hearing* edited by J. Donald Harris, in 1969. Dr. Harris published this and the now discontinued *Journal of Auditory Research*, in his basement. I would like to issue a call for any of our readers to also review an old, possibly out of print text or monograph they may have on their bookshelves for future incarnations of this column.

This issue of the *Canadian Hearing Report* also has a peer reviewed article entitled "Can Acceptable Noise Levels Be Predicted from a Noise Tolerance Questionnaire?" All articles submitted to *CHR* have the option of being peer reviewed or not and this decision is clearly indicated. The process of peer review can be difficult but the benefits can be substantial resulting in a better overall publication. Another excellent article reviews an interesting new innovation that appears to be storming the industry, "A new Approach to Protection" – well, at least for the manufacturers. The nano-coating of hearing aid circuitry to minimize moisture contamination may be a long-awaited solution to this annoying repair rate problem.

Switching gears, a number of academic clinical coordinators from around the country have put together an excellent piece on supervision and student placement in private practice settings. With private practice being the number one employer of new audiologists this is a welcome and fascinating article. One of the authors was actually a supervisor of mine way back in 1980 when private practice was just a gleam in people's eyes.

And finally, Karen Winter recounts her trip to Germany. Karen has Usher's syndrome but her limited vision and hearing certainly hasn't slowed her down. This trip and those like it are designed to be accessible and with a few alterations, have offered some intrepid world travellers the chance to travel in safety. Whenever I hear about a venue, vehicle, or a trip being made accessible, my first reaction is "why didn't I think about that?" Sometimes we all need to be reminded that equity does not mean equality.

I wish everyone a safe and pleasant summer season … and wear a hat.

Marshall Chasin, AuD, MSc, reg.CASLPO, Aud(C),
Editor-in-Chief

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PEOPLE FIRST

Comme Charles Dickens l'a écrit dans *Le conte de deux cités* au 19ème siècle, "Ce sont les meilleures colonnes; ce sont les pires colonnes … bon, il ne l'a vraiment jamais écrit, mais s'il devait lire les colonnes de ce numéro de la *Revue Canadienne d'audition*, je suis convaincu qu'il serait impressionné et aurait titré son célèbre livre *Le conte d'un nombre de colonnes formidables*. Pas aussi accrocheur mais au moins personne ne passe par la guillotine durant la révolution française.

Dans ce numéro, nous verrons l'introduction de nouvelles colonnes, en plus des anciennes. Gael Hannan est une défenseuse des consommateurs vivant avec une perte auditive. Elle travaille avec des organisations liées à l'audition pour sensibiliser aux enjeux de la perte auditive, et a livré ses présentations de marque *Rage à l'oreille* et *Voix non entendues* pour des audiences à travers l'Amérique du nord et la nouvelles Zélande. Gael siége actuellement au conseil d'administration de l'association des malentendants canadiens. Sa colonne "Du consommateur " en dit long et commence par un appel haut et fort pour une coopération entre le consommateur et les professionnels des soins de santé auditifs.

Une autre nouvelle colonne, "All Things Central" touche à tout ce qui est central, du moins au sujet des déficits des processus auditifs. La colonne est du Dr Kim Tillery. Elle est professeur et directrice du département des sciences et des troubles de communication à the State University de New York à Fredonia et exerce en cabinet privé, sa spécialité est le diagnostic et le traitement des personnes qui souffrent des déficits des processus auditifs. Kim a rédigé et co rédigé plusieurs chapitres de livres et articles de journaux traitant des déficits des processus auditifs. Elle a présenté plus de 90 ateliers et présentations à des conférences nationales, internationales et régionales au sujet des déficits des processus auditifs centraux.

Et pourquoi en rester la ? Calvin Staples est bien réputé pour son travail d'analyse des appareils auditifs et des variabilités inhérentes des premiers algorithmes adaptes. Il travaille actuellement comme instructeur au College Conestoga à Kitchener et il est aussi un coureur de distance de renommée mondiale. Calvin a accepté de sélectionner plusieurs soumissions de blog pour chaque numéro de la *Revue Canadienne d'audition* provenant du www.hearinghealthmatters.org. Un groupe composé d'audiologistes de renom et autres professionnels des soins de santé auditifs sont à l'origine de ce blog. Calvin va sélectionner quelques unes des soumissions intéressantes et celles ci vont être reproduites avec permission dans notre publication à impression à l'ancienne – Plus retro que ca ?

En parlant de retro, il est temps de dépoussiérer nos livres anciens. Une colonne semi régulière (et avec votre participation, peut-être une participation régulière) sous le nom de "Des étagères poussiéreuses " fait son apparition dans ce numéro. Récemment, Dr. Richard Seewald m'a fait l'honneur de me laisser me servir le premier en me portant acquéreur de ses livres anciens quand il a nettoyé son bureau à the University of Western Ontario. J'ai passé beaucoup trop de temps à lire ces publications extraordinaires des années 40, 50 et 60 – dont certaines qui sont aujourd'hui épuisées. J'ai pensé qu'il serait adéquat de revisiter un de ces livres anciens. Franchement, si nous ne le faisons pas, qui le ferait et ils tomberaient dans l'oubli. Pour ce numéro des étagères poussiéreuses, j'ai revisité *Forty Germinal Papers in Human Hearing* de J. Donald, en 1969. Dr. Harris a publié ceci et le *Journal of Auditory Research* qui a cessé de paraître depuis, dans sa cave. Je voudrais lancer un appel à tous nos lecteurs pour qu'ils revisitent des textes anciens ou monographies qui peut-être ont cessé de paraître, qu'ils peuvent avoir dans leurs bibliothèques pour des futures apparitions dans cette colonne.

Ce numéro de la *Revue Canadienne d'audition* contient aussi un article évalué par les paires dont le titre est "Peut-on prévoir des niveaux acceptables de bruit à partir du questionnaire de tolérance au bruit ? " Tous les articles soumis à la *Revue Canadienne d'audition* ont l'option d'être évalués par les paires ou pas et cette décision est clairement indiquée. Le processus d'évaluation par les paires peut-être difficile mais les avantages peuvent être importants résultant en une publication meilleure. Un autre excellent article évalue une nouvelle innovation intéressante qui semble avoir l'effet d'une tempête qui secoue l'industrie, "Une nouvelle approche à la protection" – bon, au moins pour les fabricants. Le nano revêtement du circuit des appareils auditifs pour minimiser la contamination par l'humidité pourrait être la solution tant attendue au problème contrariant de la fréquence des réparations.

Changeons de registre, des coordinateurs cliniciens en milieu universitaires à travers le pays ont créé un excellent travail sur la supervision et le placement des étudiants en cabinet privé. Les cabinets privés étant les premiers employeurs des nouveaux audiologistes, cet article fascinant est le bienvenu. Un des auteurs en fait était mon superviseur en 1980 quand l'exercice en cabinet privé était juste un rêve pour le publique.

Et finalement, Karen Winter retrace son voyage en Allemagne. Karen souffre du syndrome d'Usher mais sa vision et son ouïe limitées ne l'ont certainement pas ralentie. Ce voyage et d'autres du même genre sont conçus pour qu'ils soient accessibles et avec quelques modifications, ils ont offert à certains voyageurs intrépides du monde l'occasion de voyager en sécurité. A chaque fois que qu'on me parle d'un endroit, véhicule ou voyage rendu accessible, ma première réaction est "pourquoi n'y ai je pas pensé ? ". Des fois, nous avons tous besoin qu'on nous rappelle qu'équité ne veut pas forcement dire égalité.

Je vous souhaite une saison d'été plaisante et sécuritaire… et portez un chapeau.

Marshall Chasin, AuD,
éditeur en chef

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Screening setup with a senior kindergarten student at the JR Nakogee School, Attawapiskat, Ontario.

Dear Dr. Marshall Chasin and Dr. Joanne DeLuzio,

I would like to offer my sincere thanks for your generous support of my one-week Northern Initiative clinical placement opportunity in Attawapiskat, Ontario through your Seminars in Audition Scholarship.

The week I spent in Attawapiskat was truly an amazing experience. During that time my supervisor and I performed hearing screenings on 60 children and 10 adults in the community. The majority of the testing was performed at the local school, though we were also able to expand the Northern Initiative program to the hospital this year. While there we were able to set up our equipment and test some of the local elders of the community who are currently residing in long-term care.

The Northern Initiative placement gave me with the opportunity to provide audiological services to an extremely remote and underserviced area in Northern Ontario. Through this placement I gained invaluable experience and understanding of First Nations culture and of the adaptability required in this field when testing in non-clinical conditions.

Again I would like to extend my sincere thanks for your generous support of this endeavour. It was truly a rewarding and life-altering experience for which I am deeply grateful to have been a part of.

Sincerely yours,
Heather Jessome, BHSc, BA, MClSc (Aud) Candidate

Seminars on Audition offers scholarships, funded through their annual conference, to audiology students at the University of Western Ontario to attend an "extra-ordinary" facility in hopes of broadening their clinical perspective and experience.

Seminars on Audition is a non-profit seminar where all proceeds go to support student scholarships

Gus Mueller, PhD, Joins AudiologyOnline as Contributing Editor

AudiologyOnline, the leading online resource for audiology and the hearing profession, today announced that Gus Mueller, PhD., has joined the site as contributing editor.

In this role, Dr. Mueller will manage a new monthly feature on AudiologyOnline entitled "20Q with Gus Mueller" that will examine the latest topics in audiology and hearing science with other leading experts in the field. In addition to providing professionals up-to-the-minute practical information in a variety of areas, 20Q with Gus Mueller will also be available as a text CE activity for AudiologyOnline CEU Total Access members. Dr. Mueller will also lend his expertise to enhancing the AudiologyOnline eLearning live and recorded course offerings, particularly in the area of hearing instrument technology and best practices for selection, fitting, verification and achieving successful outcomes with amplification.

AudiologyOnline President Paul Dybala stated, "Dr. Mueller is one of the foremost leading experts on hearing instruments, as well as a gifted presenter and author. As a contributing editor at

AudiologyOnline, his expertise at navigating the complex world of evidenced-based research for our everyday use in the clinic and with our patients is going to benefit AudiologyOnline readers around the world. We're very excited to be working with him in this capacity."

Dr. Mueller is professor of audiology, Vanderbilt University, and has a private consulting practice nestled between the tundra and reality in Bismarck, ND. He also has faculty appointments at the University of Northern Colorado and Rush University. Dr. Mueller is a founder of the American Academy of Audiology, a Fellow of the ASHA and is the hearing aids series editor for Plural Publishing. He also is one of the earGuys at earTunes.com. Dr. Mueller is an internationally known workshop lecturer, and has published nearly 200 articles and book chapters on diagnostic audiology and hearing aid applications. He is the senior author of the books *Communication Disorders in Aging, Probe Microphone Measurements,* and the co-author of the *The Audiologists' Desk Reference, Volumes I and II.*

Gary Malkowski Receives Honourary Doctorate

Gary Malkowski, special advisor to the president, public affairs, at the Canadian Hearing Society (CHS), was bestowed the honorary degree of doctor of humane letters by Gallaudet University on May 13, 2011.

"Gary Malkowski is proof that a deaf person can achieve great things if he or she is granted adequate communication access," said Gallaudet President T. Alan Hurwitz. "Especially for young deaf men and women, his record as an elected parliamentarian and devoted advocate for the rights of deaf and hard of hearing people is a source of great pride and inspiration."

In making the announcement, Gallaudet President Hurwitz cited Malkowski's extensive work on issues of critical importance to the Deaf community, his devoted services in advancing student rights and his work in rehabilitation.

After completing his education at Gallaudet in 1984, Malkowski returned to Canada to work as a vocational rehabilitation counsellor with CHS, which since 1940 has provided services, products and information to culturally Deaf, oral deaf, deafened, and hard of hearing people.

Malkowski is tireless in the fight for accessible and equitable education for Deaf and hard of hearing students; his leadership in the Deaf Ontario Now Deaf education move-ment lead to American Sign Language and la langue des signes québécoise being rec-ognized as languages of instruction in schools for Deaf students.

In a departure from serving the community from positions in the Associations of the Deaf and in CHS, Malkowski became the first elected Deaf Member of Ontario's Provincial Parliament. Serving as parliamentary assistant and on many standing committees, he introduced a private member's bill that led to the introduction and implementation of what is now the Accessibility for Ontarians with Disabilities Act (AODA).

Supreme court rulings and decisions in support of accessibility rights of Deaf and hard of hearing Canadians are in large part due to the efforts of Malkowski.

In his current position at CHS – special advisor to the president, public affairs – Malkowski continues to work for the educational and vocational rights of deaf and hard of hearing people.

His awards for service include the Queen's Golden Jubilee Medal in recognition of his community service, the Ontario Liberal Government Community Action Award, and the

Ontario Federation of Community Mental Health and Addiction Program's Outstanding Contribution to Mental Health Communities Award.

As a further honour from Gallaudet University, Malkowski was invited to deliver what was an incredibly passionate and inspirational keynote address at the university's May 13th commencement.

In his address, Malkowski thanked the communities for their support of a body of work that "couldn't have been achieved without the communities whose rights we have fought together to defend."

Malkowski said, "I have had the opportunity and privilege to have been a part of making great strides in breaking down and removing communication barriers faced by culturally Deaf, oral deaf, deafened and hard of hearing individuals, children and their families."

He congratulated Gallaudet University for the investment it makes in its students, many of whom have become public office holders – elected politicians and senior managers at all level of government – medical doctors, chiropractors, audiologists, speech-language pathologists, and leaders in senior management including Dr. Alan Hurwitz, Gallaudet University, Gerry Buckley, National Technical Institute for the Deaf, Benjamin Soukup, Communication Services for the Deaf, and Chris Kenopic, The Canadian Hearing Society – all Presidents and CEOs.

Malkowski continued in his keynote to say that "Gallaudet University is truly a home, and is an engine for higher education that continues to be an integral tool in the building of thousands of bridges between Deaf and hard of hearing people who use signed languages and our general societies, including institutions of all levels of government."

"I am honoured to work alongside a tireless individual driven by his personal passion, exceptional pro-fessionalism, and integrity," says CHS President and CEO Chris Kenopic. "We are proud to have such a key person at CHS whose groundbreaking accomp-lishments continue to promote equity for people who are culturally Deaf, oral deaf, deafened and hard of hearing."

Submitted by Kelly MacKenzie, Director, Marketing & Communications
The Canadian Hearing Society

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HLAA 2nd International Hearing Loop Conference
Washington, DC | http://www.hlaa.org

JULY 13-15, 2011

Canadian Association of Educators of the Deaf and Hard of Hearing Conference 2011
Synergy: Working Hand in Hand for Deaf and Hard of Hearing Learners

JULY 14-16, 2011

13th Symposium on Cochlear Implants in Children
Chicago, IL | www.ci2011usa.com

AUGUST 19-21, 2011

5th International TRI Tinnitus Conference
"The Neuroscience of Tinnitus" | Grand Island, NY

SEPTEMBER 8-10, 2011

19th Annual Conference on the Management of the Tinnitus Patient
The University of Iowa
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Student Placements in the Private Practice Setting

In 2007, the journal *Social Work* published a nationwide study looking at the private practice career intentions of social work students in the United States.1 These intentions were examined and contrasted in relation to the extent which graduate students were being prepared for private practice.

In what the authors called a "striking disconnect," results indicated that, although a majority of students planned on eventually working there, programs were not providing significant content related to the private practice social work setting. Fewer than half the programs contained private practice content of any sort in the curriculums; only one-fourth of the surveyed programs agreed that private practice field placements were accepted at their schools.

The current scene for audiology students in Canada is quite different. There are five programs in audiology that currently offer clinical audiology training. These include the University of British Columbia (UBC), the University of Western Ontario (UWO), Universite d'Ottawa, Universite de Montreal, and Dalhousie University.

All Canadian audiology programs depend significantly on collaboration with private practice audiologists for placements – to one degree or another. There are a number of reasons for this. First, the scope of private practice audiology is not limited to a particular population or area of practice. It is now possible for students to work in privately run clinics where infant hearing screening, auditory processing assessment, and tinnitus counselling (to name a few examples) are routinely conducted.

Second, although the scope of private practice has expanded in recent years, the sector continues to provide considerable expertise in the traditional areas of amplification and aural rehabilitation. Simply put,

Submitted by The Academic Coordinators of Clinical Education (Audiology):
Sharon Adelman *(top)*, The University of British Columbia;
Shane Moodie *(middle)*, The University of Western Ontario;
Lynn Metthe *(middle)*, Universite d'Ottawa;
France Lacombe *(not pictured)*, Universite de Montreal;
Duncan Floyd *(bottom)*, Dalhousie University.

students need and want experience with hearing aids and private practice audiologists are in a great position to deliver this.

Third, it is likely that graduating students will, at some point in their careers, work in a private practice setting. A comparison of membership surveys from the Canadian Association of Speech-Language Pathologists and Audiologists (CASLPA) revealed an increase in private-practice audiologists between 2002 and 2008.[2] The 2005 CASLPA survey showed that 40% of respondents worked in this sector.[3]

Finally, there are many private practice audiologists who want to be involved. These are dedicated, engaged, and skilled clinicians. It is not uncommon for programs to be approached by these audiologists who want to "give back" and get involved in training the next generation. This pool of expertise is a huge resource and university coordinators naturally want their students to benefit from this.

This leads to the question raised by the article in Social Work: if professionals are inevitably to work in a particular setting, wouldn't it be best for all involved (i.e., for the students, for the profession, and for the community at large) if they were provided with guidance, training, and mentorship regarding this environment while they are students?

As enrolments rise, clinical coordinators responsible for arranging practicum placements (for all the health professions) are experiencing increasing pressure to find suitable placements for students. Consequently it is important that private practice audiologists offer their support and stewardship by carefully considering placement requests.

In order to gain some perspective on what it was like to host students in private practice, the Academic Coordinators of Clinical Education (Audiology) contacted a small group of private-practice clinicians who had experience with clinical education. Results provided some valuable insights about hosting students in this setting. We'd like to share some of these impressions.

Nicuta Gairns, AuD, from the Wild Rose Audiology Clinic in Edmonton stated that it was rewarding to see how a student develops clinical skills by the end of the practicum. She also described her clinical educator role as a "perpetual" learning experience: "A student always brings in new ideas or research information."

Audiologist Jason Schmiedge of Expert Hearing Solutions in Saskatoon agrees. He feels like he is "paying back the profession [when he] helps students gain good learning experiences." Interestingly, he reported that patients responded well to working with students: they liked the fact that his site was helping future clinicians.

Mark Hansen, AuD, owner of Sound Hearing Clinic in Vancouver pointed out that taking a student does require more time with each client and that some clients do prefer to work with their regular audiologist. In the end, however, he agreed that "most clients react favourably to working with a student." Dr. Hansen sees the act of hosting students as a way to pursue "continued education" himself. He still remembers with gratitude the audiologist who "was generous enough to provide [him] with an externship" and therefore wants to do the same for the upcoming generation.

After 29 years in the field, Regina Salomon, MSc, RAUD, RHIP, of Elite Hearing in White Rock, BC continues to be very enthusiastic about her job. She correctly indentifies this combination of experience and enthusiasm as a positive dynamic for students. She described students who are "usually very keen on learning as much as they can" and she loves to teach things that "they do not find in the books."

But were there any negatives to report? Amazingly, several respondents had absolutely nothing negative to say about hosting students. "I've never had a negative experience," stated Dr. Gairns. Jason Schmiedge reported that he has worked with "…six students over the years and each experience has been positive."

Dr. Hansen did mention that the process involves taking more time with each client. Regina Salomon agreed with this point: "I usually try to explain things as they are progressing, so it does slow me down a bit."

This would understandably be an important concern to all involved. It would not serve anyone's interests if the issue of cost-benefit related to the presence of students were not carefully considered prior to participating.

A study published in 2003 in the *Journal of Allied Health* examined the effects of student clinical education experiences on clinical instructor productivity in the profession of physiotherapy.4 The hypothesis was that teams that included students would be more productive than those without. Results showed "increased productivity on all three measures" that were studied. In the end, the data supported the notion that, for physiotherapy clinical education at least, students were associated with greater productivity for clinicians.

This is not to say that the same situation would, or should, apply for audiology practicum placements. However, it

would also be misleading to not directly address the issue. Hosting students does involve an investment of goodwill, energy, enthusiasm, time and, therefore, resources. But it can also provide tangible opportunities. This would particularly be the case once a student is established at a given site, working at a greater level of independence, and a enjoying a trusting rapport with his or her supervisor. Extra time and effort up front often creates space later on. One of our respondents commented that hosting students helped with patient workload and "allowed us to work on other tasks later on in the placements." This is the honest, forthright, and knowing statement of a seasoned clinical educator. Students require mentorship to gain independence and critical thinking skills: they can't achieve this when their supervisor hovers over them 100% of the time.

At the end of the day, it is important to remember that all private-practice respondents in this subjective exercise were enthusiastic about participating in clinical education. All recommended that other private practice clinicians consider the practicum process. All respondents described receiving adequate support from the university programs. Dr. Hansen, for example, complimented UBC's practicum handbook and online support materials. With a few caveats, patient/client reaction to the presence of students was positive. Private practice audiologists described the rewards of "giving back" to the profession and that, although being a clinical educator requires a certain type of expertise, hosting students was also, in fact, a learning experience.

So if you've ever wondered about the possibility of mentoring a student, wonder no more! All clinical coordinators at the various university programs would be grateful for your support. Any questions or requests for more information are welcome. Their students would thank you as well.

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The editors of HearingHealthMatters.org invite you to join in an exchange of information, opinions, and fresh ideas to help bridge the gaps among audiologists and other hearing practitioners, researchers, scientists, hearing aid manufacturers and educators, and ultimately, consumers.

Bridging the Hearing Healthcare Knowledge Gaps

HearingHealthMatters.org was created by and for people who share the belief that Hearing Health & Technology Matters! Our vision is to provide timely information and lively insights to anyone who cares about hearing.

Therefore, our readers and contributors will be drawn from many sectors of the hearing field, including practitioners, researchers, manufacturers, educators, and, importantly, hearing-impaired consumers and those who love them. By involving all these groups, we hope to bridge the gaps in knowledge that so often divide them.

The editors of The Blogs@ Hearing Health & Technology Matters will be constantly adding fresh content. So please bookmark HearingHealthMatters.org, and visit us regularly. And remember, these blogs are interactive, so please post your comments on what you read.

Regards,
The Editors of hearinghealthmatters.org

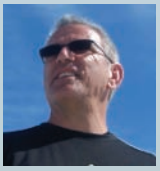
Holly Hosford-Dunn, Editor and Author *@Hearing Economics* provides an economic analysis of hearing health care.

David Kirkwood, Associate Editor and Author *@Hearing Views* and *Hearing News Watch* reports news from the world of hearing.

Marshall Chasin *@Hear the Music* asks, "What can be done to improve hearing devices for music?"

Judy Huch *@Hear in Private Practice* shares and invites ideas for managing a private audiology practice.

Wayne Staab *@Wayne's World* takes an "out of the ordinary" look at hearing aids and also hosts our sponsors @Applied Hearing Technologies.



Alan Desmond *@Dizziness Depot* focuses on the role of the inner ear in balance, orientation, and visual clarity.

K. Ray Katz *@Have You Heard?* covers the gamut of hearing-related issues in search of new ideas.

Robert M. Traynor *@ Hearing International* takes a global look at hearing-impairment worldwide, and invites guest commentary.

www.hearinghealthmatters.org

From the Blogs @Hearinghealthmatters.org

By Calvin Staples, MSc

Recently, I have been asked to select a number of blogs from HearingHealthMatters.org and submit them to *Canadian Hearing Report*. My first selections all focus on the business of hearing and hearing aids in the new industry we are presented with today. The hot topic today at annual conferences, board meetings, and at the water cooler is often the changing landscape of our industry. In the past several years, a large number of retail outlets have surfaced all across Canada. In the world of hearing health care, this is not a new phenomenon; Australia, United States, and Europe have all experienced the retail movement within our industry. However, a large number of successful privately owned and operated clinics still exist in Canada and more are opening on a regular basis. I cannot provide an argument or even a suggestion as to what I think the outcomes or impact is on the changing landscape of hearing health care, but I thought the following blogs would generate some discussion, provide some insight, and create a platform for additional input to *CHR*. Happy reading!

CANADIAN PEDIATRICIANS URGE NEWBORN HEARING SCREENING

By David H. Kirkwood

OTTAWA – When it comes to providing its citizens with health care coverage, Canada has generally gone far beyond the United States. For example, its publicly funded health system ensures that all Canadians have access to free medical care.

However, universal newborn hearing screening (UNHS), which the US introduced more than a decade ago, does not yet exist in most of its northern neighbour's provinces. However, that may change.

On May 9, the Canadian Paediatric Society released a position statement stressing the importance of UNHS. Currently only Ontario and British Columbia screen all newborns for hearing loss. Quebec approved funding of such a program in 2009, but it has not been implemented

In Canada's other seven provinces and in its northern territories, babies are generally tested only if they fall into high-risk categories, such as being born prematurely or having a serious infection.

Hema Patel, MD, lead author of the Paediatric Society's statement, stressed the importance of UNHS. She said, "This is critical and we're sadly behind the times. There's no excuse for Canada's dismal record in this area." She added that not only most other Western nations, but even some undeveloped nations, such as Nigeria, have UNHS programs.

Patel, a staff pediatrician at Montreal Children's Hospital, noted that a baby born in a province with universal screening "has the opportunity to have an early diagnosis, an early intervention, and to reach their full potential cognitively with language and communication." In other provinces, babies with hearing loss are typically diagnosed much later, after already experiencing developmental delay. As a result, said Patel, "They're going to have different outcomes – lifelong."

Rex Banks, chief audiologist at the Canadian Hearing Society, said that his group is also strongly supportive of universal screening.

http://hearinghealthmatters.org/hearingnewswatch/2011/canadian-pediatricians-urge-newborn-hearing-screening/

STRESSLESS, NO. BUT IT'S A GREAT PROFESSION NONETHELESS

By David H. Kirkwood

All you audiologists out there, I'll bet you don't know just how good you have it. After all, you have the "least stressful job of 2011." Who says? None other than Victoria Brienzi, who listed the 10 least stressful jobs in her post (www.careercast.com/jobs-rated/10-least-stressful-jobs-2011), for CareerCast, a career counselling company.

Here's how Ms. Brienzi characterized your easy profession: "An audiologist diagnoses and treats hearing problems by attempting to discover the range, nature, and degree of hearing function. The job is not typically physically demanding or stressful, but it does require a keen attention to detail and focused concentration." Actually, when you think about it, that description also applies pretty well to hearing instrument specialists. So I guess you have it pretty soft too.

What else makes the life of an audiologist so stressless, even more so than that of dieticians, speech pathologists, and philosophers, other professions on CareerCast's top ten list? Well, maybe it's that $63,144 average annual income. It sure gives audiologists peace of mind knowing that they can raise their children in comfort and pay for their college education – at least if they have a spouse in a more lucrative profession.

True, in some ways hearing care providers do face less stress than some workers. Unlike soldiers or coal miners, or surgeons, they don't run the risk of dying or killing someone on the job. And, there aren't millions of dollars riding on an audiologist's every decision. Also, demand for hearing care seems to be increasing faster than the supply, so job opportunities are better than in many fields.

But still, even by the unscientific, subjective standards of these top ten lists that are so popular on the web, this roster of "least stressful jobs" seems especially meaningless.

What Audiologists Say

I've been covering the hearing industry long enough to know that practitioners face plenty of stress. But instead of making that case for them, let me quote from a few of the people who responded (anonymously) to the CareerCast article.

One audiologist wrote, "It will never be "not stressful" to tell a parent of a child with cancer that the chemotherapy has caused hearing loss (as if this family has not been through enough)."

"Not physically demanding?" thundered another. "Ever done an Epley on a 400-pound man who is freaking out on the table? Plus I'd love to see the 'little stress' on someone's face after they've spent the last 20 minutes instructing and re-instructing someone on how to put a battery in the hearing aid only to have them insert it upside down."

Many audiologists questioned, to put it mildly, the author's expertise. One asked, "How in the world could you people decide this was the least stressful job? Have you ever told parents that their baby will wear hearing aids the rest of their life? Or tried to convince old people who think they hear fine that they need to spend thousands on hearing aids that they don't want? What a joke this article is."

Interestingly, while most respondents disputed the claim that their job wasn't stressful, many of them also extolled the virtues of audiology. For example, one complained about spending the day "trying to convince people that they need something (a hearing aid, which they do) when they don't want it." But then he or she added, it's a "very rewarding career, but hardly low-stress."

A Different Twist

Amid all the outrage, one comment stood out. For one thing, it wasn't anonymous. It was signed by Dr. Patti Kricos, president of the American Academy of Audiology." Secondly, she welcomed the article as a great recruiting tool for her profession. She wrote:

"CareerCast folks, you are right on target! Audiology is an amazing profession in so many ways! It is a rewarding career track, one that requires scientific background and an interest in technology, as well as compassion and interpersonal skills. With the huge number of Baby Boomers coming of age, there will be an even better market for audiology jobs.

"As president of the American Academy of Audiology and an audiologist for the past 38 years, I strongly encourage high school and undergraduate students to come on board to a wonderful, fulfilling profession."

Well said!

http://hearinghealthmatters.org/hearingviews/

EDUCATE INSTEAD OF "MARKETING"

By Judy Hutch

When I am chatting with my ad reps from the different local papers the same theme comes from each of them. How people are pulling back from their marketing and advertising budgets. The things that work take time and need a strong foundation, not a quick fix. Building your referral base of existing patients (or consumers where ever your preference is!) and from professionals such as family physicians, and networking colleagues. One area that really has been hit is real estate. One of the strongest companies here in Tucson, is Long Realty, they have 30% of the market share in Southern Arizona. For the past three years they have cut their newspaper, TV, radio, and other print ads down significantly. Where they have relied heavily to set them apart is education. Not only are the realtors encouraged to take continuing education, but what they send out to the public is geared to educate the public as well.

Do we think of educating as marketing? We could pick a topic a month and educate different sectors of our referral base. We can send out e-mails to our patients once a month or every quarter. But educating instead of "selling" may pay off better in the long run. If you can use as many different mediums to educate then maybe your office will be the one in mind when someone needs to have their hearing checked or are FINALLY ready to make that purchase!

http://hearinghealthmatters.org/hearinprivatepractice/2011/educate-instead-of-marketing/

REGULATION OF HEARING AIDS IN THE US: PART 2

By Holly Hosford-Dunn

Electronic Hearing Aids

At the turn of the 19th century, hearing aids underwent a technological revolution by emulating telephone technology. The first electronic hearing aids used carbon microphones that modulated electrical current in response to sound pressure variations.

The main advantages they provided were increased amplification intensity, wider frequency response of amplification, and portability.[1] These instruments did not require the user to sit or wear a beard – they were body worn and could be concealed. The first patent for an electronic hearing aid envisioned an instrument with a body-worn transmitter posing as a badge on the chest. Later devices hid in barrettes, headbands, earrings, and other camouflage connections to body worn instruments.

Hearing Aids Become a Business

Batteries and electronic components created a market for wearable amplification among people with hearing loss. Hearing aid design, which had previously been a craft or even art, changed into a manufacturing assembly process. Hearing aid manufacturing companies (e.g., Sonotone) appeared and pursued economic profit by seeking new technologies to create new products that were smaller, lighter, more powerful, and more efficient. Vacuum tubes were a major technical advance. The first wearable vacuum tube hearing aid came on the market in 1936. Beltone Hearing Aids was established several years later (1940) and quickly became one of the five largest firms in the industry (35 total firms),[2] and one of the most innovative. It introduced the first all-in-one hearing aid in 1944, which combined batteries and transmitter into a single unit.

Beltone began a relentless march to expand the market and drive sales nationally which continues even today. In 1943, Beltone set up an exclusive dispenser network that was modeled on the insurance business. It was a franchise model in which franchisees received sales training and marketing support from Beltone in return for which they sold the company's products exclusively.[3]

Other factors in the 1940s influenced the emerging hearing aid industry. Advanced munitions technologies introduced in WWII created a population of trauma victims with ear and hearing damage. Those soldiers were evaluated and treated in a new specialty ward at Walter Reed Hospital, which was staffed by an odd mix of hearing scientists and speech therapists. That alliance created a new specialty (audiology) and a new armamentarium of electronic equipment to assess and treat hearing loss. As the dimensions of hearing loss were mapped with more precision, the demand for "selective" hearing aid amplification emerged. Manufacturers responded by diversifying and improving their product lines.

WWII technological innovation benefited the hearing aid industry in its efforts to expand and upgrade. In 1947, the US government released the first printed electronic circuits to private industry. Five years later, transistor circuits were developed that once again revolutionized hearing aids. In the space of one year, from 1952–1953, almost all hearing aids switched from vacuum tubes to transistors, which miniaturized them to the point that they became ear-

level instruments rather than body-worn. Concealment became easier when hearing aids were incorporated into the stems of eye glasses. By 1959, 65% of all hearing aid sales were eye glass type.[4]

Hearing aids were big business by the 1950s. Total US hearing aid sales reached $22.1 million in 1952, a 37% rise from 1948. By 1959, Dahlberg's Miracle-Ear subsidiary had $100 million in annual revenues and was sold to Motorola, Inc.[5] In that same year, Beltone had 187 independent distributors under exclusive contract, along with 50 sub-dealer outlets.[2]

http://hearinghealthmatters.org/hearingeconomics/2011/regulation-of-hearing-aids-in-the-us-part-2/

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ALL THINGS CENTRAL

All Things Central

By Kim L. Tillery, PhD, CCC-A

About the Author

Dr. Kim L. Tillery, professor and chairperson of the Department of Communication Disorders and Sciences at the State University of New York at Fredonia also has a private practice in diagnosing and treating individuals with (C)APD. She has been honoured to present 90 workshops or presentations at national, international, and regional conferences, and authored and co-authored several chapters and journal articles on (C)APD.

Do you have clients who complain of "mishearing" a spoken word? Do they indicate that the wording of "Cinderella and the Handsome Prince" was heard as "Cinderella and the Pransome Hince" or "sadly" was perceived as "'steadily?" Of course "mishearing" may happen once in awhile to any of us due to inattention, selective listening, or a peripheral hearing loss. However, if these mishearing moments occur several times in a day and remain to be the primary complaint of an individual, then an auditory processing disorder may be the cause.

We are often asked what exactly is a central auditory processing disorder (CAPD)? A common definition often used is: CAPD is not how we hear, but what we do with what we hear.[1] In 1994 the American Speech-Language Hearing Association (ASHA) held a consensus meeting to establish a definition and proper practices in diagnosing and treating CAPD. We were provided with an extensive definition of CAPD[2] that was upheld, a decade later, in a technical report.[3] Central auditory processes were deemed accountable for common behaviours associated with auditory localization, lateralization, discrimination, and pattern recognition when nonverbal or verbal stimuli are used. There was a consensus that temporal aspects (e.g., masking, integration and order) may be compromised and the individual will show weakness when competing or degrading acoustic signals are used. The noted deficiencies may result from dysfunction of the above central auditory processes or they may be a result of a more widespread issue associated with attention or neural timing that affects one's performance across cognition, auditory and linguistic modalities.

Usually those with CAPD have normal hearing, but their responses are similar to those associated with a peripheral hearing loss. It is confusing to teachers, family members, and the individual with CAPD as to why there may be delays in responding to directions or questions. We don't worry when there is a delay from the TV reporter who is talking to a reporter in Africa. We acknowledge that distance may cause the technology to have a slow response on occasion. What about the person standing next to you who stares blankly as if the message was not heard? Well, there may be a short distance from your mouth to the temporal lobes of the listener, but there are thousands of neurons working to catch that message. If there is a disruption in the central auditory nervous system, then we may see a delay or other struggles in the response to the auditory message.

And the struggles associated with a CAPD are preconscious. The individual usually is unaware of his or her prolonged delays, frequent need for repetition of questions or directions, quiet rehearsals, omission of initial sounds or information, or need for high concentration to accurately process the spoken message. These qualitative struggles are easily recognized during daily activities, in test taking situations, and assist the clinician as to what type of auditory processing disorder (APD) the individual may exhibit.

Did you notice the switch from CAPD to APD? Actually, according to the ASHA[3] we should use the acronym (C)APD. The inclusion of the (C) reminds us that there is a "central" part to our auditory nervous system and that all that appears to be peripheral could indeed be central.

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Canadian Hearing Report 2011;6(3):20-21

Me and My Audie!

By Gael Hannan

What a dream job – being asked to produce a consumer column in the journal for hearing professionals. I admit my first thought was something like – *whoo-hoo, payback time!* An opportunity to stuff all those years of tortuous hearing tests, frustrating discussions, and expensive hearing aids into the cannon and blast it! But on second thought, I no longer feel that way towards hearing health professionals.

My former emotions have long-since morphed into a healthy admiration for audiologists, manufacturers of assistive technology, and frankly anyone who dedicates *their* work to improving the quality of *my* life.

The change didn't come easily. Some years ago, trying to adjust to new, state-of-the-art CIC hearing aids, I was well into a frustrated and teary rant against a poor fit, breaking battery cages and wax guards that kept falling into my ear, when my husband cut me off with, "Gael, they're not doing this just to irk you. Have more respect for technology and science!"

That gentle admonishment stopped me in my tracks and brought home how far hearing science had come since age three when the pediatric ENT told my parents that hearing aids would never help me. My husband's reality check was one of those life-changing moments that ultimately spurred me to a life of hearing loss advocacy.

Since then, through meeting and working with consumers and professionals from all corners of the hearing arena, I've come to believe in a few guiding principles for living successfully living with hearing loss:

- We must be honest. (Yes, I do have hearing loss)
- We must be knowledgeable. (What do I need to know about my hearing loss? Who can help me?)
- We must be proactive and use all available communication tools and strategies, to the best of our ability.
- We must communicate our needs to others.

In order to live by these principles, people with hearing loss need support from many sources, including peer support from hard of hearing people, but most specifically from our hearing care professionals. If we have even the tiniest motivation to break through the barriers and achieve successful communication, we must look at hearing professionals as our allies.

Although this might seem like a no-brainer to you, it represents a seismic shift in consumer attitude, especially from those of us who are long-time hearing aid users. Like most people with hearing loss, my annual hearing check-up was not a red letter day. Getting the same news year after year was depressing: *Your hearing has dropped. No, it won't get any better so don't expect a cure. It's time for new hearing aids. Yup, they're still ugly. Doubled in price, too.*

But now, thanks to an explosion in hearing technology and access to information, the old stigma is drifting away, and a new consumer population is evolving, one that has a better grasp of the complexities of managing hearing loss.

As a result, we expect today's hearing professionals to be well-trained experts in diagnostics, technology, psychology and communication strategies. We depend on you to provide quality hearing aids, answer our difficult questions and search out solutions to our communication needs. You are also expected to face us when you talk to us.

And, frankly, we don't feel all this is too much to ask. In fact, we ask for one more thing, especially for new hearing aid users – the provision of aural rehabilitation programs that ensure we incorporate these necessary communication strategies into our everyday lives.

A few years ago, audiologist Joanne DeLuzio and I developed *Me & My Audie: The Important Partnership of Consumer and Hearing Health Professional*, a presentation aimed at both consumers and audiologists. Its premise is that aural rehab is not limited to a course of action prescribed by a hearing care professional. Instead it begins with the first personal suspicion of a hearing loss, which starts a communication journey that will be most successful when supported by a solid consumer-professional relationship.

As an individual hard of hearing person and as a member of several consumer hearing loss organizations, I celebrate this partnership and look forward to sharing our perspective in coming issues of the *Canadian Hearing Report*.

Canadian Hearing Report 2011;6(3):22

Implementation Science

By Sheila T.F. Moodie, MCI Sc
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"There is a current trend to develop test protocols that are "evidence based." But, before we develop any new fitting guidelines, maybe we should first try to understand why there is so little adherence to the ones we already have"[1]
– HG Mueller

To address Dr. Mueller's challenge to better understand why there may be little adherence by hearing health care professionals to currently available clinical practice guidelines (CPGs), we need to examine not only the guidelines (development, content, recommendations, etc.), but we also need to examine if and how these guidelines are being implemented into clinical practice. The most fundamental limitation of CPGs is that they are often not implemented or adhered to in practice. That is, they often do not change practice behaviour. Analyses of the barriers to practice change indicate that obstacles to change arise at many different levels: at the level of the guideline, the individual practitioner, the organization, the wider practice environment; and at the level of the patient.[2–6]

WHAT IS IMPLEMENTATION?

Critical components for moving knowledge into clinical practice include: adapting the knowledge to the local context in which it will be used; assessing the barriers and facilitators to knowledge use; ensuring appropriate implementation interventions (e.g., training, tailored targeted protocols) are in place during an implementation stage; the knowledge use monitoring stage; the evaluation stage and the stage at which strategies are implemented to sustain knowledge use.[6–11] The interested reader is directed to the text *Knowledge Translation in Health Care: Moving from Evidence to Practice*[11] for additional information about knowledge translation.

Within the knowledge to action process, the term implementation refers to the uptake of research knowledge and/or other evidence-based practice (EBP) protocols into clinical practice through a specified set of activities (for example, the specific steps involved in application of a CPG) with the objective of improving the quality and effectiveness of health care.[7,12–14]

WHAT IS IMPLEMENTATION RESEARCH?

Implementation research is the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices and protocols into routine clinical practice and health care policy context. It includes the study of influences on healthcare professionals and organizational behaviour.[15–17] At its core, implementation research is about studying change; change in practice behaviour and maintaining change in organizations.[14]

ENGINEERING CHANGE TO FACILITATE UPTAKE AND IMPLEMENTATION OF EVIDENCE

According to much of the recently published implementation research, implementation interventions are likely to be more effective if they target causal determinants of behavior.[14,18–23] The challenge at this point in the very young field of implementation science and research is developing systematic methods that incorporate an understanding of the nature of the behaviour to be changed and an appropriate system for characterizing intervention and their components that build on this understanding.[21,23]

THE BEHAVIOUR CHANGE WHEEL

Recently a proposed new framework for changing behaviour has been published.[23] The framework starts with the question: "What conditions internal to individuals and in their social and physical environment need to be in place for a specified behavioural target to be achieved?"[23] At the centre of this framework is a "behaviour system" composed of three essential conditions: capability, opportunity, and motivation (it is being referred to as the COM-B system). Figure 1, from Michie et al., 2011 illustrates the COM-B system. The system acknowledges and appreciates that individual, group and organizational factors can have equal impact on, and control behaviour. **C**apability is defined as "the individual's psychological and physical capacity to engage in the activity concerned." Capability includes knowledge and skills. Implementation is a social, dynamic and iterative process, consequently opportunity is an important component to the COM-B system. **O**pportunity is defined as "all the factors that lie outside the individual that make the behaviour possible or prompt it." Finally, **M**otivation is defined as "all those brain processes (including habits, emotional responding and analytic decision-making) that energize and direct behaviour." There is interaction among the components of the COM-B system. Capability and opportunity can influence motivation and executing a behaviour can modify capability, opportunity and motivation.[23]

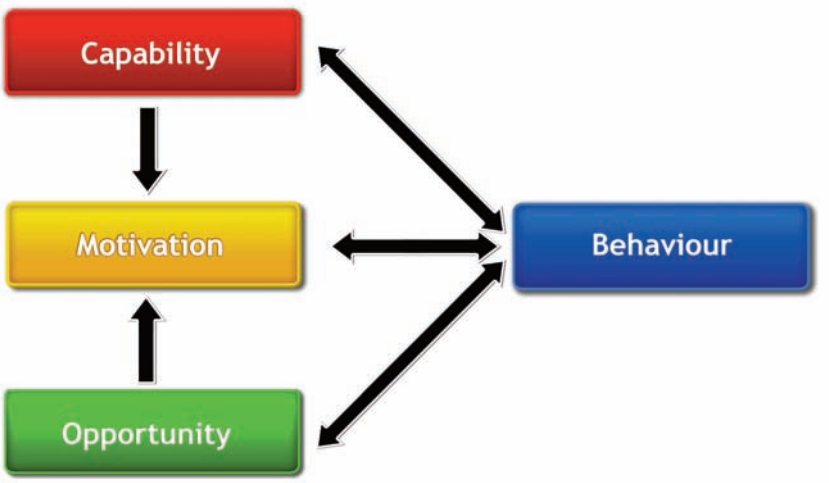

Figure 1. The COM – B system for understanding behaviour. Reprinted from Michie et al.[23]

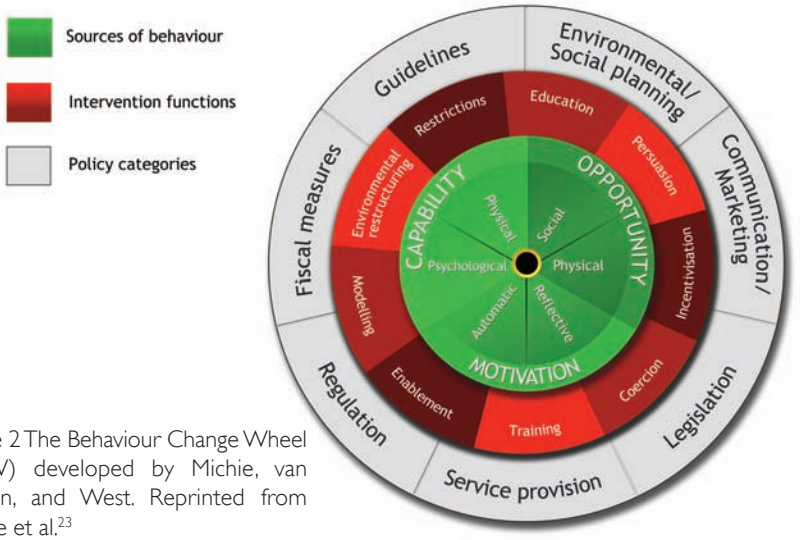

Figure 2 The Behaviour Change Wheel (BCW) developed by Michie, van Stralen, and West. Reprinted from Michie et al.[23]

Each of the COM-B system components can be further divided into categories that could be targeted to cause a behaviour change. As explained by Michie et al.[23] capability can be divided into physical and psychological (reasoning, comprehension, etc). Opportunity can be divided into physical (environmental/contextual) and social opportunity (for example, the way concepts are developed to shape how we thing about things). Finally, motivation is divided into reflective processes (self-evaluation, for example) and automatic processes (impulses, emotions, etc.). The developers of the COM-B system recognized during development that targeting behaviour change must occur at the individual, group, organizational and policy-maker levels. This led to the development of the behaviour change wheel (BCW). The BCW is composed of the COM-B system and its associated subdivisions at the hub, encircled by behaviour change intervention functions and then by policy categories. Figure 2, adapted from Michie et al.[23] illustrates the behaviour change wheel. One primary advantage to having the potential intervention and policy categories visually present in the wheel is that it assists with a systematic analysis and selection of interventions and policies that might be most effective in changing particular target behaviours.

Table 1. Definitions of interventions used in the Behaviour Change Wheel framework.

Interventions	Definition
Education	Increasing knowledge or understanding
Persuasion	Using communication to induce positive or negative feelings or stimulate action
Incentivisation	Creating expectation of reward
Coercion	Creating expectation of punishment or cost
Training	Imparting skills
Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviour)
Environmental restructuring	Changing the physical or social context
Modelling	Providing an example for people to aspire to or imitate
Enablement	Increasing means/reducing barriers to increase capability or opportunity. Capability beyond education and training: opportunity beyond environmental restructuring

Reprinted from Michie et al.[23]

Table 1 provides associated definitions of the list of interventions within the BCW. The BCW was used reliably to characterize interventions within the English Department of Health's 2010 tobacco control strategy and the National Institute of Health and Clinical Exellence's guidance on reducing obesity.[23] The BCW is being developed into a theory and evidence-based tool for use within varied healthcare settings.

BACK TO THE ORIGINAL QUERY FROM DR. MUELLER

> *"There is a current trend to develop test protocols that are "evidence based." But, before we develop any new fitting guidelines, maybe we should first try to understand why there is so little adherence to the ones we already have" – HG Mueller*

The findings from audiology research and the development of best practice protocols and guidelines cannot positively impact the patients in our care unless healthcare systems, organizations, and professionals adopt them in practice. Therefore, this article has as its objective to put the "spotlight" on several exciting new areas in health care research that could be used by researchers, policy makers and practitioners to answer Dr. Mueller's query and to guide future translation of knowledge into clinical practice in audiology. Knowledge translation frameworks such as the knowledge-to-action process provide an evidence-based approach for understanding how to move knowledge into clinical practice. The behaviour change wheel facilitates understanding of behavioural interventions that could be utilized to improve and sustain implementation. Implementation research provides a scientific methodology for the evaluation of the influences of behaviour (individual, organizational and policy) on healthcare practice and policy.

We can use knowledge translation and implementation research frameworks to develop some potential research questions to start to address guideline adherence issues in audiology.

What barriers are present within the clinical contexts in which audiologists work that affect adherence to CPGs? What implementation interventions have been used to move CPGs into clinical practice? Which ones have been successful? What conditions internal to audiologists and in their social and physical environment need to be in place for a specified behavioural target (appropriate and consistent use of a CPG for example) to be achieved? What policies might be in place that improve audiologists adherence to CPGs? Of course, asking these questions prior to, or during the guideline development process may lead to improved adherence.

CLOSING THOUGHTS ABOUT THE BEHAVIOUR CHANGE WHEEL

A close examination of the behaviour change wheel shown in Figure 2 should lead the reader to see that this might be an excellent framework to use in clinical practice to develop behaviour change interventions for individuals who wear hearing aids.

DISCLOSURE

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ACKNOWLEDGEMENT

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Canadian Hearing Report 2011;6(3):23-26

I recently came into possession of a gem of a book published in 1969. It is called *Forty Germinal Papers in Human Hearing* edited by J. Donald Harris, and for those of us over the age of 50, we remember him as a the brainchild of The Journal of Auditory Research, which published from 1969 to 1987. *The Journal of Auditory Research* served as the publisher for this collection but the 40 articles are from a wide range of sources and publications.

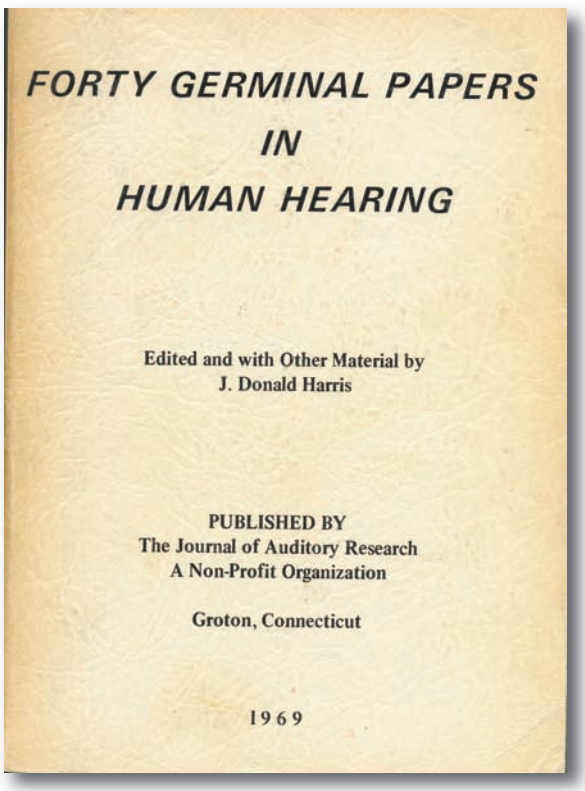
Upon opening the cover of the book I was accosted by the acrid smell of an old book that hasn't been opened in decades which brings back fond memories of browsing the library stacks late at night in an attempt to delay doing a math problem set or other equally distasteful endeavour. From Dr. Harris's preface: "It is customary on occasions such as this to define the diners for whom the feast is spread…. One is he who loves to lie in a hammock in his orchard of a summer afternoon, a glass of switchel in one hand and a good book on psychoacoustics in the other…. One reads not only to inform, to memorize tables and figures and principles, but also to relish with the experimenter his viewpoints on a problem, his hopes, his trials and frustrations, his surprises, failures, and perhaps even his triumphs". (p. v).

This column will hopefully be the first in a long string of remembrances from books of the past. I would like to urge you to run to your bookshelves, pick out the oldest, dustiest audiology book that is out of print, or long forgotten, and write a similar review for our readers.

Marshall Chasin, AuD, MSc, reg. CASLPO, Aud(C),
Editor-in-Chief

Forty Germinal Papers in Human Hearing - a source book in psychoacoustics,

J. Donald Harris (Ed.), The Journal of Auditory Research: Groton, Conn., 1969.



This book is divided into 9 sections: 1. Absolute Intensive Threshold; 2. Masking, Critical Ratio, and Critical Bandwidth; 3. Frequency Selectivity; 4. Differential Intensive Threshold; 5. Psychological Attributes of Sound; 6. Loudness, Its Definition and Relation to Frequency; 7. Psychological Scaling; 8. Adaptation, Sensitization, and Fatigue Processes; and 9. Binaural Hearing. Many of the articles reviewed either were required reading or were referred to in our first course in psychoacoustics and it's a pleasure to have the original source material together in one publication.

Only an overview of the first section will be given which is historical in nature. I will "gloss over" the content of subsequent sections and our memories can fill in the rest.

Section One contains excerpts on the "Minimal audible pressure and minimum audible field" by L.J. Sivian and S.D. White (JASA, 1933) who were contemporaries of Fletcher and Munson (who also published in 1933). This is followed by "The Limits of Low-Frequency Hearing" by Glen Wever and C.W. Bray (*Journal of Psychology, 1937*). This was the seminal paper that discussed the

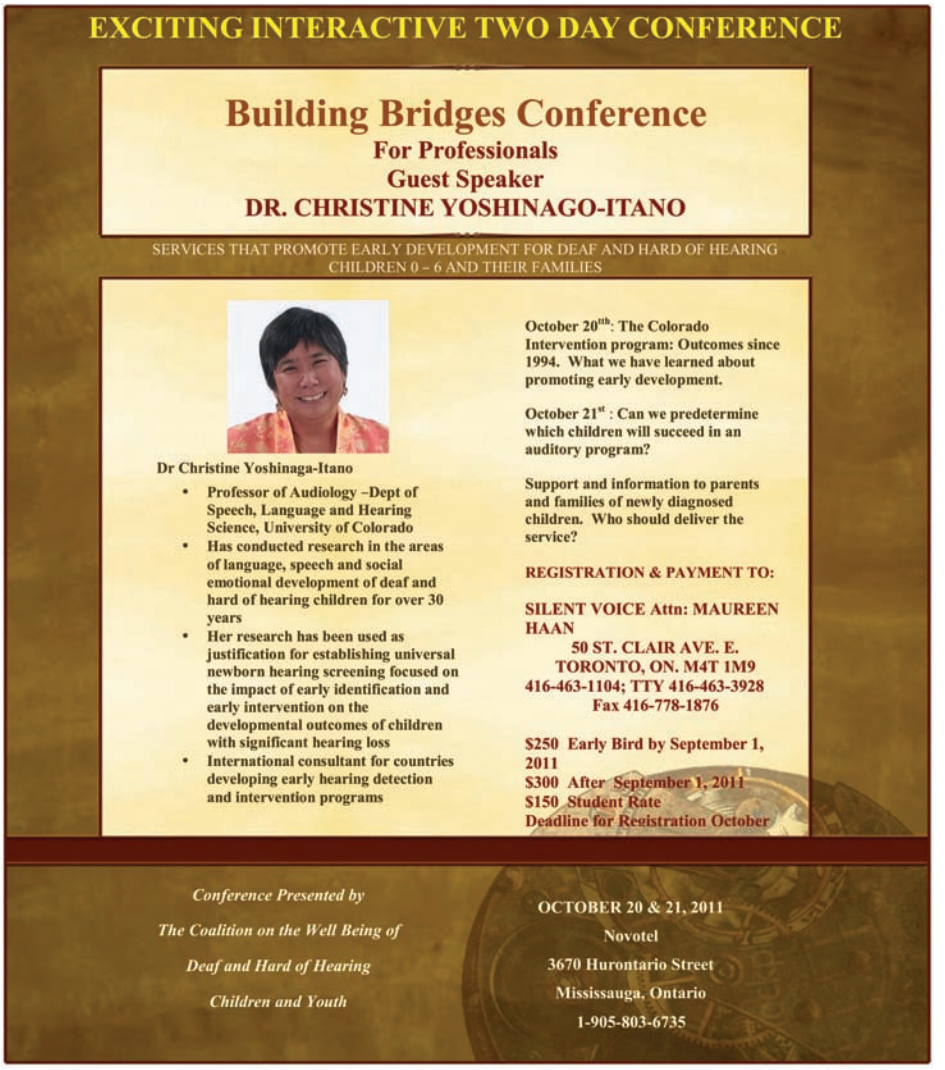
resonance volley theory of sound. The next paper began the voyage into the perception of brief tones- "Acoustical quanta and the theory of hearing" (Nature, 1947). In the 1930s and 1940s, anything with the word "quanta" in the title was almost guaranteed publication because of the excitement and success of the Quantum Theory. This shouldn't detract from the importance of the paper since it spawned the field of brief tone audiometry. This is followed by a seminal (by only 4-page long) paper on temporal integration entitled "The threshold of audition for short periods of stimulation" by J.W. Hughes (in Proceedings of the Royal Society (London), 1946). And finally this section is rounded out by a paper entitled "A determination of the normal threshold of hearing and its relation to the standardization of audiometers", (Journal of Laryngology and Otology, 1952). As can be seen from the publication date, this article took umbrage with the ISO 1951 standard and led, in part to the ASA 1964 standard (a precursor to the ANSI 1969 standard).

Subsequent sections are a listing of everything that we need to have at our fingertips to properly discuss psychoacoustics, explain it in lay terms to our patients, and even serve as a topic over a beer. All too often we only have access to other people's summaries, and unless we have an up actually said in 1940 with his article on Auditory Patterns. The same can be said about Zwicker, Flottorp, and Stevens' article on the Critical bandwidth in loudness summation. Moving forward to loudness and intensity we move forward to 1933 to re-examine the Fletcher/Munson curves with commentary 20 years later by D.W. Robinson and R.S. Dadson (in the British Journal of Applied Physics). D.W. Robinson is perhaps best known to us from his ground breaking work on noise exposure in large populations.

The importance of temporal cues in binaural hearing (E.M. von Hornbostel and M. Wertheimer, 1920 translated by J. Donald Harris) and temporal cues (M. Upton, 1936) have been well studied since but were all based on these two publications. And while we are talking about binaural affects, we finish with an excellent study of binaural beats and their frequency limits by J.C.R. Licklider, J.C. Webster, and J.M. Hedlum in JASA in 1950.

This book will undoubtedly occupy some of my mid-summer reading, but unlike J. Donald Harris's liking of a switchel, I'll stick with something a little more mundane.

Canadian Hearing Report 2011;6(3):127-28



A Holiday in Germany for Persons with Usher's Syndrome

By Karen Winter

Editor's note: This is from the EDBU website:
The European Deafblind Union (EDBU) is an association that joins together European deafblind people's organizations. It was founded in 2003, and it is an international non-governmental and non-profit organization.
The basic aim and function of the EDBU is to work toward equality and full participation in society by deafblind people in all European countries.

The EDBU is a European forum for the exchange of knowledge and experience in the field of deafblindness which also works to increase European solidarity among deafblind people's organizations.
Their website is http://www.edbu.org/.

The following article was written by Karen Winter who recently attended a European tour with other people, many of whom have Usher's syndrome.

From August 2–8, 2010, I participated in the European Rehabilitation Cultural Week of the Deafblind. The holiday was held in the university town of Tubingen, Germany, with its medieval town centre and castle. It is a very nice place. The participants were from Canada, Russia, Finland, Hungary, Denmark, Sweden, Norway, Belgium, Germany, and Switzerland. There were a total of 130 participants, including the guides. (Each participant had his/her own guide.) Many of the people had Usher's type 1 and type 2. Usher's type 1 is complete deaf/blindness from birth. Usher's type 2 is acquired in young adulthood. In addition, there were some persons who were deaf, but their vision was not impaired.

I was the only participant from North America. I have Usher's type 2. The onset of my hearing loss started in my late teens and my vision loss started in my mid-twenties. The deterioration of my vision is due to a retinal eye disease called retinitispigmentosa (RP), which is progressive and leads to blindness. RP causes a loss of approximately 10% of vision each year. There is no treatment for this genetic disease.

The participant's guides' holiday fees were paid for by the governments of Sweden, Denmark and Finland. The Deaf and Blind Association in Hungary paid for the fee of the participant's guides. Hungary's Deaf and Blind Association receives funding from the European Union. The fee for the participant's guide is 450 Euros, which is approximately $550.00 Canadian, and the fee is the same for the participant. The people, who did not receive subsidies, paid 900 Euros, plus transportation costs.

The holiday was wonderful. Each day there were two choices of activities. The activities included a visit to a bread museum in the city of Ulm, where participants baked bread in the museum's kitchen; the museum's guide explained the socio-economic impact of bread on European society; a visit to a Porsche Car Museum near Stuttgart; a tour of a 14th century museum farmhouse in the Black Forest which I especially enjoyed; a tour of the Costume Museum in the Black Forest

(there are interesting costume festivals in the Black Forest towns to-day, that grew out of medieval superstitions); a visit to a castle in Tubingen, a hike in the valley to a very old monastery that is a restaurant to-day, and serves good beer, and many other cultural and fun activities.

I have very good memories from the people I met and the holiday activities. I feel that most of the participants had the same experience of really enjoying the holiday. I enjoyed the company of the participants a great deal. I spent time with the participants from Belgium, Finland, Sweden, and Denmark. The Swedes and Danes were a lively bunch.

Peter, who is from Belgium, made a strong impression on all of us. He is completely deaf and blind, and he is in his 30s. Peter has attended the university in the Flanders region of Belgium, and he has studied physiotherapy. In the future, he plans to return to his studies at the university for an additional two years. Peter indicated that if he is unable to find employment as a physiotherapist, he hopes to work as a massage therapist. His guide interpreted what Peter explained to us via Lorm, which is a language the deafblind persons use. Lorm is a hand manual language and involves forming sentences by touching the fingers to represent the letters of the alphabet. Lorm, or hand manual, is the communication method used by completely deafblind persons. Peter indicated that he goes to both of the public schools for young children and the universities in Belgium, and he gives a presentation about life as a deafblind person. He is athletic; he swims, he likes to ride on a tandem bike, and he goes kayaking in Belgium's waterways. Peter also travels within Europe. When asked why he isn't married, Peter responded that he likes his job as a bachelor. His various remarks brought a lot of laughter to the dinner table. He has a full life.

Then there was the man from Sweden, named Ingmar. Ingmar is deaf, and he has very restricted vision. He is in his 60s. Ingmar likes to take photos; his passion is his train set, and he travels a lot and has even been to China. Ingmar indicated that he receives a lot of social support from the Swedish government. At the end of the holiday, Ingmar and his two Swedish guides had plans to travel by train to a city in Germany where there is a train museum. I think Ingmar also indicated there was a program in this city for train enthusiasts. Ingmar planned to visit there for three days with his guides before he returned to Sweden.

My guide, Signe, and I especially liked to spend time with Gaetan and his wife, Petra, who are from Flanders. Gaetan has Usher's type 2, and his condition is similar to my own. Gaetan works in a government office, and he travels whenever he can. He plays soccer, and he leads a support group for people who have Usher's. He was great company.

Usher's syndrome is a terrible condition. There are very few people in life who experience losing both of their vision and hearing, and I feel lucky that I had the experience of meeting a lot of people who have managed to transcend the huge burden that Usher's has given them. Their example makes it possible for me to continue to find ways to make my own life the best that I can.

In August 2011, Finland will host the ERCW holiday. In 2012, the ERCW holiday will be held in Denmark. It seems that a sizeable number of Europeans who are deafblind, have the opportunity to participate in a holiday rich in culture each year in a different European country. The access is made possible due to generous subsidies from the government, and in some cases, from the Catholic diocese church. (The holiday is secular.) The support of the government and other sources of funding to facilitate the wonderful holiday for the deafblind is a testament of the value that is placed on the participants.

Canadian Hearing Report 2011;6(3):29-30

Can Acceptable Noise Levels Be Predicted from a Noise-Tolerance Questionnaire?

By Karrie Recker, AuD, CCC-A, FAAA, Martin F. McKinney, PhD, and Brent Edwards, PhD



Karrie Recker, *(left)* is a research audiologist at Starkey Laboratories. She joined the company in 2000. Over the years Dr. Recker has been involved in a variety of research projects ranging from basic hearing science studies to algorithm testing to mechanical design verification. In 2005, she received her doctoral degree in audiology from the University of Florida.

Martin F. McKinney, *(middle)* holds a BS degree in electrical engineering from Tufts University, an AM degree in electroacoustic music from Dartmouth College and a PhD in speech and hearing sciences from Massachusetts Institute of Technology. Dr. McKinney currently works as a senior DSP research engineer at Starkey Laboratories, Eden Prairie, MN.

Brent Edwards, *(right)* completed his PhD. in electrical engineering at the University of Michigan in 1992, and subsequently a postdoctoral fellowship in psychology at the University of Minnesota. Dr. Edwards has worked in industry since 1995. In 2004, Dr. Edwards joined Starkey Laboratories, where he is currently vice-president of research.

ABSTRACT

The Acceptable Noise Level (ANL) test is a measure of the amount of background noise that a person is willing to tolerate. In recent years it has gained interest among researchers and hearing care professionals because of its ability to predict, with 85% accuracy, who will be successful with hearing aids. This statistic is not only useful for counselling purposes, but it implies that if one could understand why different people are able to tolerate different amounts of background noise, then one could gain insight into what makes a patient successful (or unsuccessful) with hearing aids. This knowledge could be used to target hearing-aid solutions to the individual to improve her prognosis with hearing aids. However, several studies have been unsuccessful at correlating ANLs with audiological factors other than hearing-aid success. This article reviews some of the ANL literature, speculates on the potential future applications of the ANL test and reports the results of a questionnaire that was administered to 139 participants to gain insight into the potential mechanisms underlying individuals' ANLs.

CAN ACCEPTABLE NOISE LEVELS BE PREDICTED FROM A NOISE-TOLERANCE QUESTIONNAIRE?

The Acceptable Noise Level (ANL) test is a measure of the amount of background noise that a person is willing to tolerate.[1] In recent years it has gained interest among researchers and hearing-care professionals because of its ability to predict, with 85% accuracy, who will be successful with hearing aids.[2] This statistic is not only useful for counselling purposes, but it implies that if one could understand why different people are able to tolerate different amounts of background noise, then one could gain insight into what makes a patient successful (or unsuccessful) with hearing aids. This knowledge could be used to target hearing-aid solutions for an individual to improve her prognosis with hearing aids. However, several studies have been unsuccessful at correlating ANLs with audiological factors other than hearing-aid success. This article reviews some of the ANL literature, speculates on the potential future applications of the ANL test and reports the results of a questionnaire that we administered to gain insight into why different individuals are willing to tolerate different amounts of background noise.

Performing the ANL test is relatively quick and simple. First, running speech is presented to a listener over headphones or via sound field. Often the Arizona Travelogue is used as the speech stimulus (Cosmos, Inc.). This passage consists of continuous discourse by a male talker discussing his travels in Arizona. Using an adaptive procedure, the listener is first instructed to adjust the level of the speech to a level that is "too loud" then "too soft" then "most comfortable to you." Next, background noise is added, usually multi-talker babble, and the listener is instructed to adjust its level, first to a level that is "too loud to understand the speech" then to a level that is "soft enough for the speech to be very clear" and finally to the highest level that she is "willing to put up with" while following the speech. The difference between the listener's most comfortable listening level (MCL) and her maximum tolerated background noise level (BNL) is her ANL. The test takes about 2–3 minutes to administer.

A lower ANL score reflects a higher tolerance for background noise. According to Nabelek et al.,[2] there are three different ANL categories – low, mid, and high. Individuals who have "low" ANLs (less than 7 dB) are generally successful hearing-aid wearers, whereas individuals who have "high" ANLs (greater than 13 dB) are generally unsuccessful hearing-aid wearers. People with "mid" ANLs (7 to 13 dB) may or may not be successful with hearing aids. Nabelek et al. showed that most hearing-impaired people had ANLs between 0 and 25 dB; the most frequently-occurring ANLs were around 10–11 dB.

ANLs do not appear to be related to an individual's age[1,2] gender[2,3] hearing sensitivity[1,2] or preference for the existence of background sound.[4] At present, it is ambiguous whether ANLs are related to an individual's speech understanding abilities – some researchers[5,6] suggest that ANLs and speech intelligibility are uncorrelated while other researchers[7] suggest that people with better speech intelligibility skills also have lower ANLs. Similarly, studies examining aided and unaided ANLs have produced conflicting results, with Nabelek et al.[6] showing that ANLs are the same regardless of the test condition and Ahlstrom et al.[7] showing that aided ANLs are lower than unaided ANLs.

In addition to these findings, both directional microphones and noise reduction technology have been shown to improve (lower) listeners' ANLs by about 2.5–4 dB over the aided condition without these features active.[8–10] These results are exciting because they suggest that hearing-aid features and hearing-aid signal processing allow people to tolerate higher levels of background noise, which may in turn improve listeners' success rates with hearing aids. Moreover, if we could understand the cues that individuals are using to determine their tolerance of background noise, this information could offer insight into who is most likely to benefit from these technologies.

Because the ANL instructions request that listeners be able to follow the primary talker, it is possible that some individuals adjust the level of the background noise based on a speech-intelligibility criterion. If this is true, then we suspect that these individuals will be more likely to benefit from directionality, or other SNR-enhancing technology, than listeners who base their ANLs on some other criteria.

However, the ANL instructions do not require listeners to adjust the level of the background noise until a certain speech intelligibility criterion is reached. Because listeners are simply asked how much background noise they are "willing to put up with" while following the speech, they may be basing their decision on some other criterion such as how loud or how annoying the background noise is. If someone were basing her ANL on the loudness of the background noise, then she may be more likely to benefit from hearing-aid features that reduced the loudness of the noise, such as noise reduction.

Although each manufacturer's noise-

reduction algorithm will function differently depending on the environment, generally, the smaller the temporal fluctuations are in a signal, the more likely the noise-reduction algorithm is to classify a signal as "noise" and reduce the gain of the hearing aid. Specifically with the ANL test, the background "noise" is 8-talker babble. With this many talkers, the temporal fluctuations in the signal are substantially less than what is observed with a single talker, and so the noise reduction algorithm may recognize it as noise and reduce the gain of the hearing aid. In real-world environments, such as restaurants or bars, there may be many more than 8 talkers, and much higher levels of reverberation than occur in a sound booth. Both of these factors will reduce the temporal fluctuations in the signal and increase the likelihood that a noise-reduction algorithm will classify "babble" as noise. Other factors that will affect whether a noise reduction algorithm activates include the overall level of the environment and an estimate of the SNR. Finally, once "noise" is detected, the time constants of the algorithm will determine whether the overall gain of the hearing aid is decreased or whether the gain is only decreased between the pauses of speech. This latter type of noise reduction technology may be especially useful for listeners who are basing their ANLs on loudness, because it will preserve the loudness of the speech signal while reducing the loudness of the "noise" between the pauses of speech. Listeners who base their ANLs on listening effort may also be good candidates for noise-reduction technology, because it has also been shown to reduce listening effort and free up cognitive resources for other tasks.[11]

Determining whether the cue underlying a listener's ANL is predictive of her success with different hearing-aid features is of interest because historically it has been very difficult to predict who would benefit from various features, as a listener's performance in the laboratory may not correlate well with her real-world benefit.[12–15] For example, in a double-blind study involving 94 hearing-aid wearers who were fitted for one month with directional technology and one month with omnidirectional technology, Gnewikow et al.[14] found that participants performed significantly better on all of the laboratory (speech-in-noise) tests with the directional settings than with the omnidirectional settings; however, similar ratings were obtained for the two microphone settings on almost all of the subjective measures of benefit (the Profile of Hearing Aid Benefit (PHAB) and the Satisfaction with Amplification in Daily Life (SADL) questionnaires). The authors concluded that, "self-perceived directional benefit is either limited in magnitude, not readily measured using general outcome measures, or both."[14]

If the cues that listeners are using to determine their ANLs are predictive of hearing-aid feature benefit, then knowledge of individuals' ANLs, and the cues that they are using to determine their ANLs, could be used to better counsel patients and to customize hearing solutions for them. Knowledge of this information could also benefit hearing-aid manufacturers, as it would allow them to predict when, where and for whom certain hearing-aid features would provide benefit. Ideally, this would result in a better first fit, less fine-tuning adjustments, and happier, more satisfied, hearing-aid wearers. As an initial step in determining the cues that listeners are using to determine their ANLs, we created a questionnaire to determine how listeners view their performance in noisy situations compared to quiet ones.

METHODS

As a first step in determining what cues listeners may be using to select their ANLs, we compared individuals' ANLs to their responses to a custom questionnaire (Appendix). The questionnaire investigated the perceived negative impact that background noise has on speech intelligibility, stress levels and concentration levels. Additionally, it asked participants about their own perceived tolerance for background noise and whether or not they typically avoid situations known to have high levels of background noise. Finally, hearing-aid wearers were asked to describe their hearing-aid use following the categories defined by Nabelek et al.[2]: (a) I wear my hearing aids whenever I need them, (b) I only wear my hearing aids occasionally, and (c) I do not wear my hearing aids.

The goals of this questionnaire and the ANL testing were threefold. First we wanted to determine whether participants' responses to these questions could provide insight into why some people are more tolerant of background noise than others. This information could help explain why some people are more successful hearing-aid wearers than others, and it could help guide future ANL research. Second, we wanted to determine whether a short questionnaire is sufficiently accurate at predicting individuals' ANLs that it could be used as an alternative method of predicting hearing-aid success. If so, the questionnaire could replace the ANL test, thereby eliminating the need for electronic equipment to produce and verify the levels of the test signals. Also, if the patient were to complete the questionnaire prior to her visit with the audiologist, the audiologist could save

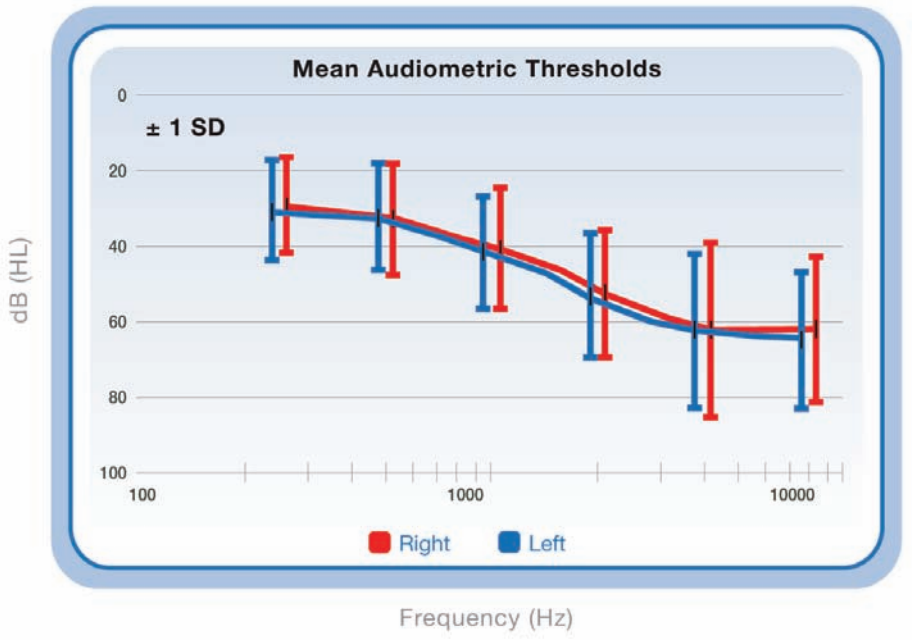


Figure 1. Mean audiometric thresholds ± 1 standard deviation (SD).

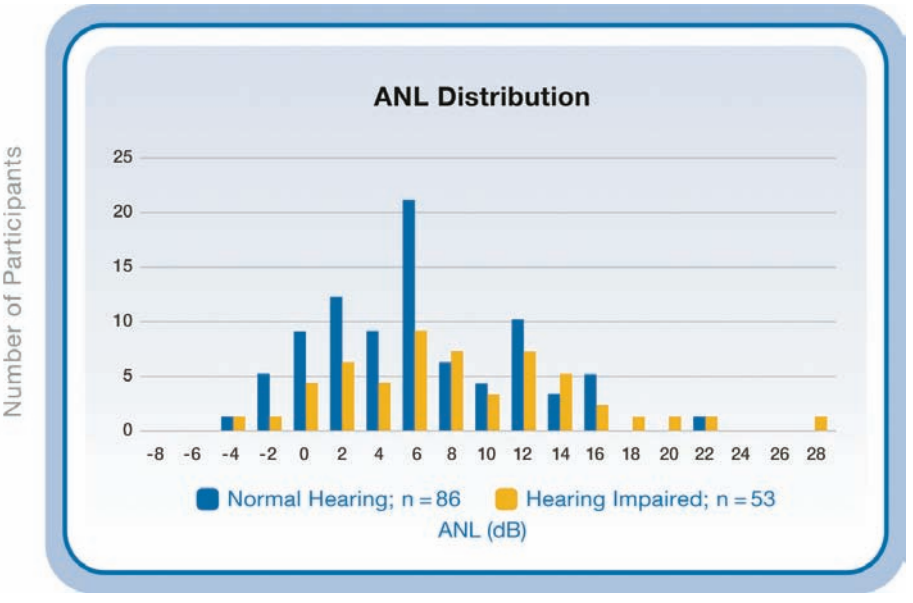


Figure 2. Distribution of ANLs for normal-hearing and hearing-impaired participants.

2–3 minutes of time that would otherwise be required to perform the ANL test. Third, we wanted to replicate the Nabelek et al.[2] study to determine whether ANLs are predictive of hearing-aid success for our test population.

In all, 86 normal-hearing and 53 hearing-impaired individuals participated in this study. Normal-hearing participants were Starkey employees who had volunteered to participate in research. Hearing-impaired participants were members of our research database; most had bilateral, mild-to-moderately severe sensorineural hearing loss (Figure 1). Forty-three of these participants were full-time hearing-aid wearers. All had digital hearing aids that were built between the years of 2000 and 2010 (median year built = 2007). All individuals signed a consent form before participating.

For each of the questions on the questionnaire, participants were asked to consider their performance in a "noisy" situation compared to a quiet one. A quiet situation was chosen as a reference so that participants would focus on the increased difficulty of the task caused by the background noise. Participants were asked to consider the "noisy" situation as being the equivalent to a crowded restaurant or bar. This reference was chosen because the type of background noise that one encounters in this situation is likely to be fairly similar to the multi-talker babble that was used during the ANL testing.

Using the standard ANL stimuli (the Arizona Travelogue (Cosmos, Inc.) and 8-talker babble), the ANL test was performed five times during a single session for each of the participants. The first iteration was practice; the remaining 4 iterations were averaged to obtain the listener's ANL. All participants were tested unaided. For the questionnaire, each question used a 4 or a 5-point scale.

RESULTS/DISCUSSION

ANL Distribution

Figure 2 shows the distribution of ANLs for the normal-hearing and hearing-impaired groups. Normal-hearing participants had a mean ANL of 5.1 dB, with a range of –4.4 to 21.6 dB, and hearing-impaired participants had a mean ANL of 7.3 dB, with a range of

–4.1 dB to 27.5 dB. A Mann Whitney Rank Sum test showed that ANLs were significantly lower for the normal-hearing group compared to the hearing-impaired group ($p < .05$).

For both groups, the mean ANLs were lower than the average ANLs of 10–11 dB reported by Nabelek et al.[2] The only potential explanation that we have for this is cultural differences. A majority of the normal-hearing people who participated in this study worked for a hearing-aid manufacturer. Many of these individuals have had past experiences that have led them to have a special interest in hearing or sound (e.g., personal experience with hearing loss, experience participating in psychoacoustic experiments, advanced musical training or audio engineering experience), and these experiences may have caused them to relate to sound differently than a random sampling of the population. Additionally, as previously stated, many of the hearing-impaired individuals were full-time hearing-aid wearers. Nabelek et al.[2] has shown that there is a moderate correlation between ANLs and amount of hearing-aid use, and so the fact that many of our hearing-impaired participants were full-time hearing-aid wearers may have biased our results toward lower ANLs.

Questionnaire Results

For analysis purposes, each multiple-choice response on the questionnaire was assigned a number 1–5. Low numbers indicate that background noise had minimal perceived negative impact on the listener's performance on that task and high numbers indicate that background noise had a large perceived negative impact on the listener's performance on that task.

What Factors Affect Listeners' ANLs?

To determine which question or combination of questions was best able to predict listeners' ANLs, a regression analysis was completed to investigate the relationship between an individual's ANL and her survey response scores. For both normal-hearing and hearing-impaired participants, results showed that concentration levels, perceived speech understanding abilities and tolerance for background noise were the primary factors influencing listeners' ANLs. Combining these three factors resulted in only slightly better predictive performance than using the single best factor. For the normal-hearing participants, the top three factors gave a coefficient of determination (R^2) of .1627 ($F_{4,81} = 5.3$, $p < .005$) whereas the single best factor – individuals' perceptions of their own noise tolerance – gave an R^2 of .1207 ($F_{2,83} = 11.5$, $p < .001$). For the hearing-impaired participants, the three top factors gave an R^2 of .1861 ($F_{4,48} = 3.7$, $p < .05$) whereas the best single factor – perceived speech understanding abilities – gave an R^2 of .1410 ($F_{2,50} = 8.4$, $p < .01$).

The low correlations between these variables and participants' ANLs suggest that none of these factors is singularly driving listeners' ANLs. Potentially, this could mean that different individuals are using different cues to determine their ANLs or that cues other than the ones that were investigated in this study are driving listeners' ANLs. Alternatively, it is possible that the questionnaire format did not sufficiently capture the variables of interest.

Can ANL Group Membership Be Predicted?

Because the ANL category to which an individual belongs should be predictive of her success with hearing aids, we wanted to determine whether we could predict individuals' ANL categories based on their responses to questions 1–6 of the questionnaire. To investigate this, we performed a quadratic discriminant analysis (QDA). This analysis tried to predict the ANL group (low/mid/high) to which an individual belonged based on her responses to the questions. The results of this analysis showed that the questions had poor predictive ability. At best the ANL category to which an individual belonged could be accurately predicted 54% of the time for normal-hearing participants and 49% of the time for hearing-impaired participants; chance performance was 33%. In general, there was too much overlap in participants' responses to the questions to accurately categorize them into the different ANL groups.

Can Success with Hearing Aids Be Predicted Based on Participants' Responses on the Questionnaire?

To determine whether any of the questions 1–6 on the questionnaire could be used to accurately predict success with hearing aids, we examined the responses of the 43 hearing-impaired participants in this study who reported owning hearing aids. Of these 43 people, 36 (84%) would be considered successful hearing-aid wearers according to Nabelek et al.'s[2] classification scheme, meaning they reported wearing their hearing aids whenever they needed them (question 8). Only 7 people (16%) would be considered "unsuccessful" hearing-aid wearers, meaning they only occasionally (5) or never (2) wore their hearing aids. Due to the small sample sizes, it was not possible to draw definitive conclusions regarding the ability of these questions to predict success with hearing aids. However, preliminary data showed that the mean participant responses on each of the questions were fairly similar

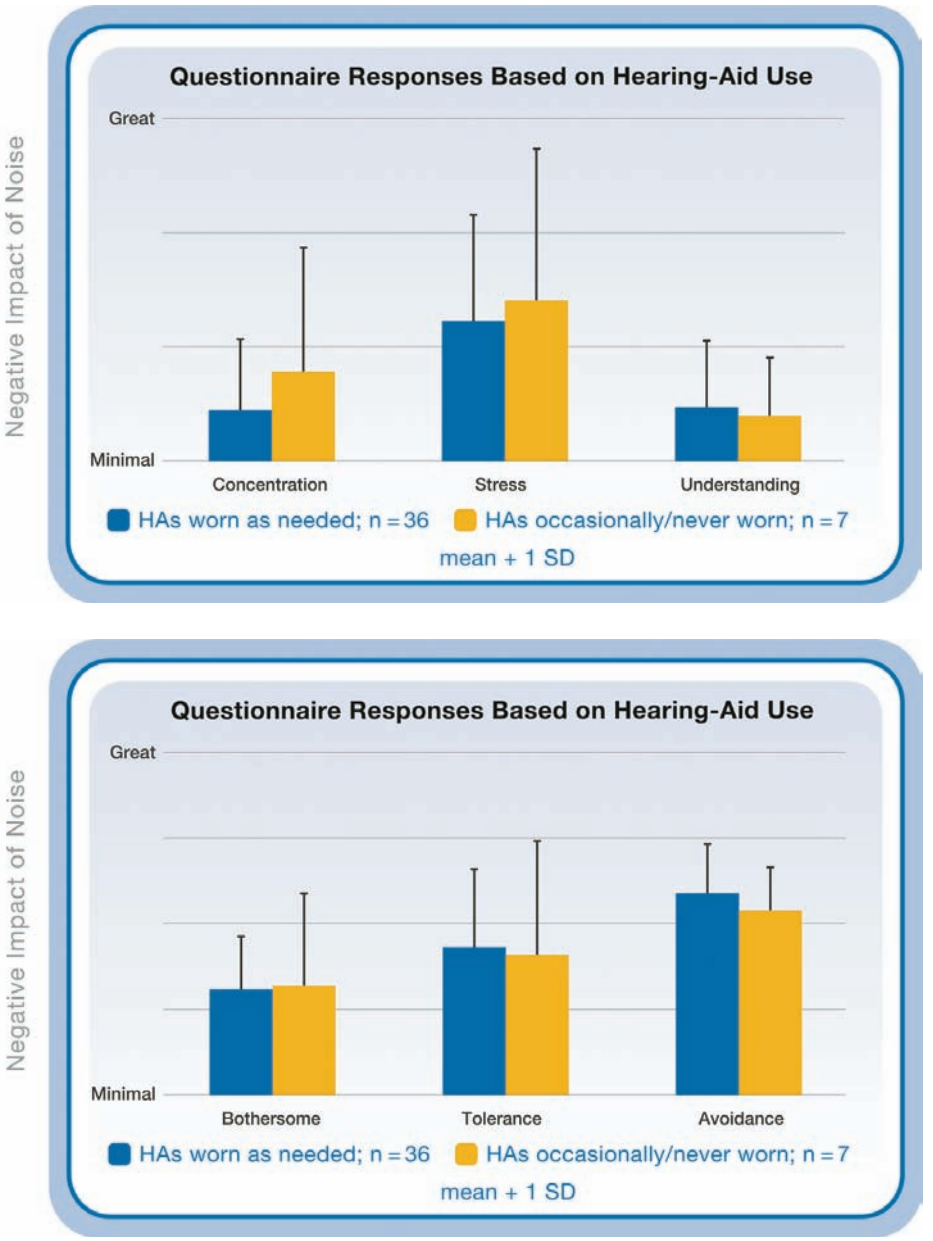


Figure 3. Hearing-aid wearers' mean responses (+ 1 SD) to the first six questions on the questionnaire. Questions that used a 4-point scale are on the top, and questions that used a 5-point scale are on the bottom. Participants' data were grouped according to their hearing-aid use.

across the different hearing-aid use groups, suggesting that participants' responses on this questionnaire are unlikely to be predictive of hearing-aid success (Figure 3).

Do ANLs Predict Success with Hearing Aids?

According to Nabelek et al.[2], people with low ANLs are likely to be successful with hearing aids, whereas people with high ANLs are likely to be unsuccessful with hearing aids. To determine whether this same trend occurred for our participants, we compared hearing-aid wearers' ANL groups to their responses to question 8 on the questionnaire (which classified them into successful and unsuccessful hearing-aid wearers, as discussed above). We found that 85% of our participants with low ANLs (17 of 20), 83% of our participants with mid ANLs (15 of 18) and 80% of our participants with high ANLs (4 of 5) would be considered successful hearing-aid wearers. These percentages are much higher than the 36% of individuals that Nabelek et al. suggested would be successful hearing-aid wearers. Additionally, they do not show the same strong trend for hearing-aid success to decrease with increasing ANL score. Again, differences between our results and those reported by Nabelek et al. may be due to biases in the way in which our participants were recruited.

CONCLUSION

Historically it has been very difficult to predict who would be successful with hearing aids. Research by Nabelek et al.[2] has offered hope that hearing-aid success may be predicted with a high degree of accuracy using a simple test investigating the amount of background noise that listeners are willing to accept while listening to running speech. The current questionnaire was administered to gain insight into the potential cues that listeners may be using to determine their ANLs, which may offer an explanation as to why some individuals are successful with hearing aids while others are not. The results of our study showed the following:

- The distribution of ANLs for our participants was much lower than what has been reported in the literature.[2] This would suggest that most of our participants should be successful with hearing aids. In fact, 84% of the hearing-aid wearers in this

study would be considered successful hearing-aid wearers based on Nabelek et al.'s definition of hearing-aid success. It is possible that our participant selection method may have biased the findings of the current study toward lower ANLs and therefore more successful hearing-aid wearers.

- For the normal-hearing and the hearing-impaired groups, there were mild, but significant, correlations between participants' ANLs and their responses to questions on concentration levels, perceived speech understanding abilities and tolerance for background noise. While these results suggest that these variables may play a role in listeners' ANLs, the low correlations suggest that none of these factors is singularly driving listeners' ANLs.
- The results of the questionnaire did not accurately predict the ANL category to which an individual belonged nor did they accurately predict whether or not someone was successful with hearing aids.
- For our population, ANLs were not predictive of hearing-aid success.

The results of this study suggest several areas in which additional research is necessary. First, existing research should be replicated to address the discrepancies between our results and those of other researchers to confirm that the observed differences in ANL distribution and hearing-aid success are, in fact, due to population differences and not some other variable. Second, future research should focus on determining the cues that individuals are using to select their ANLs. In particular, it may be useful to investigate the potential roles that concentration and speech intelligibility have on ANLs, given that significant correlations were observed between both of these variables and listeners' ANLs. Finally, research is necessary to determine whether the cues that individuals are using to determine their ANLs are in fact related to user benefit with various hearing-aid features. The results of these studies could have far-reaching implications for the treatment and rehabilitation of those with hearing loss.

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APPENDIX: QUESTIONNAIRE

For these questions, think about how your experiences in noisy environments compare to your experiences in quiet environments

Circle your response.

1. In noisy situations (e.g., a crowded restaurant or bar), I _____ more difficult to concentrate than when in quiet situations.

a. find it much
b. find it somewhat
c. find it slightly
d. rarely find it any

2. In noisy situations (e.g., a crowded restaurant or bar), I_____ more stressed than when in quiet situations.

a. feel much
b. feel somewhat
c. feel slightly
d. rarely feel any

3. In noisy situations (e.g., a crowded restaurant or bar), I_____ more difficult to understand the speech of those sitting next to me than when in quiet situations.

a. find it much
b. find it somewhat
c. find it slightly
d. rarely find it any

4. I usually find high levels of background noise, like those encountered in a crowded restaurant or bar, to be…

a. extremely bothersome
b. very bothersome
c. somewhat bothersome
d. slightly bothersome
e. rarely bothersome

5. I consider myself to be…

a. extremely intolerant of background noise
b. very intolerant of background noise
c. somewhat intolerant of background noise
d. slightly intolerant of background noise
e. very tolerant of background noise

6. I…

a. usually avoid situations that have high levels of background noise
b. frequently avoid situations that have high levels of background noise
c. sometimes avoid situations that have high levels of background noise
d. occasionally avoid situations that have high levels of background noise
e. rarely base my decision on whether to enter an environment on the level of the background noise

7. Do you have hearing aids?

a. Yes (go to question #8)
b. No (questionnaire is complete)

8. How often do you use your hearing aids?

a. I wear my hearing aids whenever I need them
   - Approximately how many hours? _____
b. I only wear my hearing aids occasionally
   - Approximately how many hours? _____
c. I do not wear my hearing aids
   - Why do you not wear them?

_____

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A New Approach to Protection

By Stephen Coulson, PhD, Chief Technical Officer P2i.

About the Author

Stephen invented the P2i technology while carrying out his PhD at Durham University on "Liquid repellent surfaces." He was consequently employed by the MoD to set up a plasma capability and further scale-up the patented technology for industrial applications. In 2001, Stephen moved into project managing the UK Nuclear Biological and Chemical clothing program, but continued to exploit the plasma technology for a range of commercial applications. Stephen was the founding member of P2i when it was formed in January 2004 and has more than a decade's experience in advanced material sciences and plasma processing

Modern hearing instruments are increasingly miniature, sophisticated and fragile, and difficult to protect from moisture damage. Aridion, P2i's liquid repellent nano-coating for electronics, aims to transform standards of reliability by overcoming the limitations of traditional approaches.

According to Hearing Industries Association data, the proportion of behind-the-ear (BTE) models sold increased to 64% in 2009 from 57% in 2008, comprising almost 1.7million units in total, reaching their highest-ever market share of 66% in the fourth quarter of 2009. But closer scrutiny of the figures also reveals that 40% of the BTEs sold in 2009 were the latest, smallest, most discreet devices, and almost three quarters of those were receiver-in-canal (RIC) BTEs. These figures reflect the growing aspiration, especially among younger users, for a hearing instrument that can be worn unobtrusively, and for more extended periods of time as an integral part of an active lifestyle. However, as designs become smaller and more delicate, they are also increasingly difficult to protect. Hazards faced by hearing instruments are principally liquids, such as sweat, water, and humidity.

For example, in the January 2010 issue of *Hearing Review*, the "Field Study on the Effect of Relative Humidity on Hearing Aid Receivers" highlighted the very strong correlation between receiver problems and relative humidity between 60 and 90%. Because RIC/BTE devices are delicate and contain expensive digital electronics, repair costs (to manufacturers via warranty failure, or users via accidental damage) are potentially very high, especially given the current trend towards wearing binaural devices (one for each ear). What is needed is a means of protecting the delicate components of hearing aids against the effect of aqueous and oleous (e.g., cerumen) contaminants.

OLD TECHNOLOGIES HAVE REACHED THEIR LIMIT

Old ways of protecting the delicate electronics in hearing instruments have involved the use of spray or dip applied coatings, but three limitations in particular undermine this approach.

1. Coatings are applied to individual components of the outer casing. After assembly, not all of the instrument will be protected equally.
2. Spray and dip coatings are not durable and rub off over time.
3. Spray and dip coatings can be too thick to protect fine-tolerance acoustic components without affecting their performance.

Aridion, technology by P2i, overcomes these limitations in a new and very different way. Plasmas have long been known for their use in modifying the

surface properties of materials. Aridion uses a special ionized gas (plasma), created in a vacuum chamber, to apply a pinhole-free protective polymer layer over the entire surface of a finished, fully-constructed hearing instrument. This layer is nanoscopically thin, but lowers the surface energy significantly so that when liquids come into contact with it, they form beads and simply roll off.

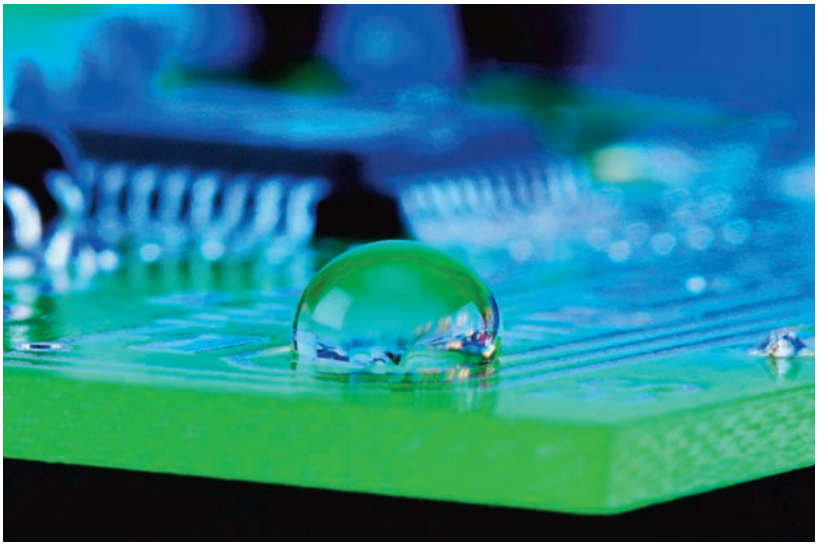
The way Aridion treats finished articles, and readily penetrates their complex structures, is a radical improvement on traditional coatings. This is because the patented technology works at a pressure that allows full penetration of the complex device, while the energized gas allows durable attachment to the plastics, metals and rubbers from which the product is constructed. This results in total device protection at the nano scale.

It's also important to note that Aridion technology is solvent-free and uses only tiny quantities of protective monomer, resulting in minimal waste and no adverse impact on the environment.

NO NEED TO SWEAT OVER RELIABILITY

Reduced corrosion has been demonstrated by P2i in the industry standard sweat test. This common industry test exposes a hearing instrument placed on a prosthetic ear to continual drops of a sweat solution for several days. Following this, the amount of corrosion is determined visually and various diagnostic tests are run.

Before/after images show that no visible corrosion occurs in the Aridion™ protected device after the sweat test; visible corrosion is apparent, however, in the uncoated sample. In tests with multiple samples, 100% of the Aridion



protected products pass while 80% of the uncoated products fail. This leads to an extended product lifecycle, consumer confidence that the instrument is working correctly and both reduced return rates and warranty costs.

It's also very important to ensure that hearing aids with Aridion can be worn next to the skin and function correctly, for an extended period of time. P2i has carried out a number of different bio-compatibility tests and subject tests, where the nano-coating is placed in contact with human skin for a prolonged time period.

For example, P2i commissioned a "repeat insult" patch test of 50 human subjects to evaluate skin irritation or sensitization, using cotton and polyester processed with P2i's liquid repellent nano-coating technology. The results showed Aridion to be non-irritating and non-allergenic. Further tests by the device manufacturers have confirmed that these medical instruments can be worn next to skin.

FIT AND FORGET

Because the Aridion nano-coating establishes permanent molecular bonds with the surface substrate, it is much more durable and robust than traditional approaches. P2i's tests show that Aridion is five times more durable than traditional coatings, possessing superior abrasion resistance properties to other surface coatings used in the industry.

For example, in a test that simulates the effect of day-to-day abrasive wear of the hearing aid housing, samples protected with Aridion maintained an effective degree of water repellence over 600 abrasion cycles, whereas uncoated samples lost their effectiveness after just 100 cycles. One reason for this is that the strong molecular bonding of the nano-coating means it doesn't leach away. It's also the case that older technologies can only be applied to the plastic housing, and so don't protect the delicate electronics within the device.

Importantly for increasingly miniature devices, the Aridion coating does not affect the performance of acoustic components in the same way as traditional approaches. It is one thousand times thinner than a human hair, making it acoustically transparent and imperceptible to users.

PERFORMANCE … WITH PRACTICALITY?

The proven protective qualities of Aridion are now providing unbeatable protection against corrosion damage for more than three million hearing aid users worldwide. Licensed by three of the largest hearing aid manufacturers, Aridion is transforming conventional levels of reliability by substantially reducing warranty failure and repair costs and ultimately increasing user confidence.

CONCLUSIONS

When complete hearing instruments are treated using the Aridion process, they achieve much stronger resistance to liquids than would be possible by assembling components individually treated using alternative techniques. The resulting improved product reliability is likely to decrease the number of repairs required per unit, saving money, time and frustration for manufacturers, dispensers and end users alike.

With three of the world's major hearing aid manufacturers now having adopted Aridion as part of their technology portfolios, and three million devices now protected using the technique, the benefits of Aridion are now moving further into the mainstream. The challenge is now to keep spreading the benefits of Aridion to wider and more diverse audiences, for example smaller manufacturers and even dispensers.

This may be particularly relevant in areas of the world where Aridion protection is most needed, but may be less straightforward to deliver – for example in regions of South America and South Asia with high humidity and a less affluent clientèle. At P2i we're hoping we've begun to address that need with the launch of the Aridion 8 machine, which opens up the possibility of for cost-effective and efficient processing at lower product volumes.

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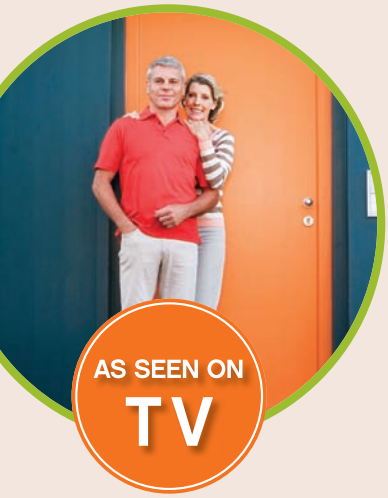

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