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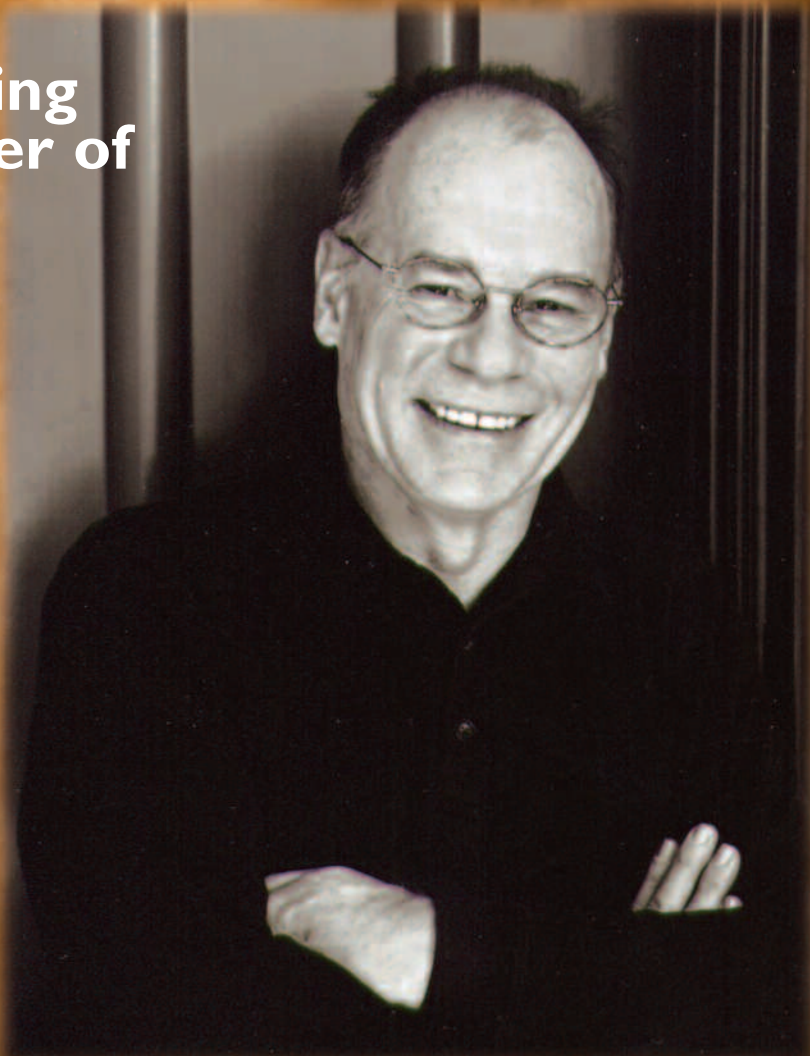
Vol. 4 No 4

Celebrating the Career of Richard Seewald



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The name Dr. Richard Seewald is synonymous with "Child and Infant Hearing Aid Fitting," just as the name Marshall Chasin is synonymous with "Good looking bearded guy" (see picture). I first met Richard in the late 1980s in Halifax during a talk about real ear measurement, and despite the fact that the technology was very new to the field, Richard seemed to know more about it than the conference speaker!

Shortly afterwards he moved to central Canada (still eastern Canada to our western readers) and set up shop at the University of Western Ontario in London, Ontario. From that point onwards, it became the industry and professional norm to read every article published by Richard, whether it was about RECDs or something called DSL. Both of these terms are now central to every clinical practice around the world (and even in parts of Australia). I wouldn't say that my mother and father know about DSL but it's amazing how ubiquitous this acronym is. Dr. Ruth Bentler tells of a story when she was accosted by a Canadian custom's agent during a trip up to Canada and the agent wanted to know her opinion of the difference between DSL and NAL. It turns out that the agent's roommate was a person who was enrolled in one of Richard's classes at the University of Western Ontario but this story still points out that DSL can be found everywhere (or that the custom's agent was a bit of a nerd).

This is a special issue dedicated to the work and accomplishments of Richard in honour of his retirement. However, knowing Richard, I suspect that he will be "retired" in name only and will continue to contribute in some way to our field for years to come. Two of Richard's previous students, and now professional colleagues, Dr. Susan Scollie and Dr. Lorienne Jenstad have taken up the task of being guest editors for this issue of the *Canadian Hearing Report*. Susan is currently at the University of Western Ontario and Lorienne is at the University of British Columbia. Susan and Lorienne have done a wonderful job, and this issue is something that will be on my bookshelf (and/or coffee table) for years to come.

Le nom Dr. Richard Seewald est synonyme de "Dispositifs des appareils auditifs chez le bébé et l'enfant," tout comme le nom Marshall Chasin est synonyme de "Bel homme barbu" (voir photo). J'ai rencontré Richard pour la première fois à la fin des années 80 à Halifax durant une conférence sur les mesures réelles de l'oreille, et même si la technologie était toute nouvelle au domaine, Richard semblait en savoir plus que le conférencier!

Par la suite, Richard a déménagé dans la région centrale du Canada (toujours l'Est du Canada pour nos lecteurs de l'Ouest) et s'est installé à the University of Western Ontario à London, dans l'Ontario. Depuis, c'est la norme de l'industrie et de la profession de lire chaque article publié par Richard, que ce soit au sujet des RECDs ou quelque chose appelée DSL. Ces deux termes sont maintenant primordiaux à toute pratique Clinique à travers le monde (et même dans certaines régions de l'Australie). Je ne dirai pas que ma mère et mon père ont entendu parler du DSL mais c'est incroyable ce que cet acronyme est ubiquiste. Dr. Ruth Bentler a cette histoire à raconter, au cours d'un de ses voyages au Canada, elle a été interpelée par cet agent des douanes canadiennes qui voulait avoir son avis sur la différence entre DSL et NAL. Il s'est avéré que le ou la colocataire de l'agent était inscrit(e) à un des cours de Richard à the University of Western Ontario mais cette histoire illustre le fait que le DSL est partout (ou que l'agent des douanes était un peu maniaque).

Ce numéro est spécialement dédié au travail et aux réalisations de Richard pour honorer son départ à la retraite. Néanmoins, connaissant Richard, je me doute bien qu'il sera " à la retraite" seulement en titre et il va continuer à contribuer d'une manière ou d'une autre à notre domaine pour les prochaines années. Deux des étudiantes de Richard, maintenant des collègues professionnelles, Dr. Susan Scollie et Dr. Lorienne Jenstad vont assurer la fonction de rédactrices scientifiques invitées de ce numéro de *La Revue Canadienne de l'Audition*. Susan est actuellement à the University of Western Ontario et Lorienne est à the University of British Columbia. Susan et Lorienne ont réalisé un excellent travail, et ce numéro sera dans mon étagère de livres (et/ou table de salon) pour les prochaines années.

Je voudrai aussi vous rappeler à toutes et à tous que vous pouvez faire des dons à la bourse d'entrée en

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I would also like to remind everyone that they can donate to the Richard C. Seewald Entrance Scholarship in Audiology which will be awarded annually to a full-time student entering the first year of the audiology program in the School of Communication Sciences and Disorders at The University of Western Ontario, who demonstrates a strong professional commitment, as well as academic excellence. To contribute to the scholarship or for further information, please contact Catherine Dorais-Plesko, The University of Western Ontario, at 519-661-2111x85199 or cdoraisp@uwo.ca.

Finally, I would also like to thank the publishers of both *Hearing Journal* and *Ear and Hearing*, for their gracious permission to reprint some of Richard's earlier works. In particular we have been able to reprint Richard's seminal 1985 article in *Ear and Hearing* that started the ball rolling on DSL.

I wish Richard and his family a healthy and happy retirement.

Marshall Chasin, AuD., Reg. CASLPO, Aud(C),
Editor in Chief

Audiologie de Richard C. Seewald qui sera attribué annuellement aux étudiants(es) inscrits(es) à temps plein en première année du programme d'audiologie à the School of Communication Sciences and Disorders à The University of Western Ontario, qui font preuve d'un fort engagement professionnel, en plus d'une excellence académique. Pour contribuer à cette bourse ou pour plus amples informations, veuillez s'il vous plaît, contacter Catherine Dorais-Plesko, The University of Western Ontario, au 519-661-2111x85199 ou cdoraisp@uwo.ca.

Finalement, je voudrai aussi remercier les éditeurs de Hearing Journal et Ear and Hearing, de nous avoir gracieusement permis de réimprimer quelques travaux précédents de Richard. En particulier, nous avons pu réimprimer l'article hors pair de 1985 de Richard apparu dans Ear and Hearing qui a été le précurseur du DSL.

Je souhaite à Richard et à sa famille une retraite en bonne santé et heureuse.

Marshall Chasin, AuD., Reg. CASLPO, Aud(C),
Éditeur en chef

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This edition of *Canadian Hearing Report* is a tribute to a man who is a pioneer of audiology not only in Canada, but around the world.

Throughout this edition you will read all about Richard Seewald; researcher, educator, mentor, philanthropist, and friend.

Fourteen years ago a group of audiologists were sitting around a table in Dallas, involved in a lively debate about audiology in Canada. There was a napkin upon which were written the names of individuals who were interested promoting audiology in Canada. This was the genesis of the Canadian Academy of Audiology and Dr. Richard Seewald was one of the names on that napkin. Dr. Seewald was there in the beginning and continues to be there today to foster the development and growth of the Academy. Over the years he has been a member of the CAA board as well as an integral part of the first All-Canadian Conference in Audiology. He has educated us in the ways of pediatric amplification and has participated in more than one panel discussion on topics such as infant hearing and the future of audiology in Canada.

But Richard's contributions to CAA go beyond this. Over the years, through his beautiful art work, he has helped CAA raise thousands of dollars to support the academy's objectives and projects. He has never been one to shy away from a challenge or request. He is always willing to lend a helping hand to promote the endeavours of the academy, promote audiology and the profession of audiologists in Canada and around the world. As a mentor Richard has inspired many new audiologists including myself. In this edition you will hear many of these stories, both personal and professional.

On behalf of the Canadian Academy of Audiology I would like to say thank you to Dr. Richard Seewald for all of his contributions. We wish you all the best in your retirement and we hope that you will continue to provide leadership and guidance to audiologists across Canada.

Carri Johnson
President
Canadian Academy of Audiology
president@canadianaudiology.ca

Cette édition de la *Revue Canadienne d'Audition* est un hommage à un homme, un pionnier en audiologie non seulement au Canada mais partout dans le monde.
Dans l'ensemble de ce numéro, vous allez tout savoir sur Richard Seewald; chercheur, éducateur, mentor, mécène, et ami.

Quatorze ans plutôt, un groupe d'audiologistes attablés à Dallas, étaient engagés dans un vif débat sur l'audiologie au Canada. Sur une serviette étaient inscris les noms des personnes qui étaient intéressées à la promotion de l'audiologie au Canada. C'est la genèse de l'Académie Canadienne d'Audiologie et le nom du Dr. Richard Seewald était un des noms dans la serviette. Dr. Seewald a été dans le début et continue d'être présent aujourd'hui pour stimuler le développement et la croissance de l'Académie. Au fil des années, il a été un membre du conseil de l'ACA en plus d'être une partie intégrante de la première Conférence Entièrement Canadienne en Audiologie. Il nous a formé à l'amplification pédiatrique et a participé à plus d'un panel de discussion touchant des sujets tels l'ouïe chez les bébés et le futur de l'audiologie au Canada.

Mais les contributions de Richard à l'ACA vont au-delà. Au fil des années, grâce à son beau travail artistique, il a aidé l'ACA à lever des fonds de milliers de dollars pour soutenir les projets et les objectifs de l'académie. Il n'a jamais été de ceux qui se rétractent en face d'un défi ou d'une requête. Il est toujours prêt à promouvoir les entreprises de l'académie, promouvoir l'audiologie et la profession des audiologistes au Canada et dans le monde. Comme mentor, Richard a inspiré plusieurs jeunes audiologistes y compris moi-même. Dans cette édition, vous allez entendre plusieurs de ces histories, autant personnelles que professionnelles.

Au nom de l'Académie Canadienne d'Audiologie, je voudrai remercier Dr. Richard Seewald pour toutes ses contributions. Nous vous souhaitons le meilleur pour votre départ à la retraite et nous souhaitons que vous allez continuer à fournir le leadership et l'orientation aux audiologistes au Canada.

Carri Johnson
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"QUICK NOTES"

FROM THE EXECUTIVE DIRECTOR

This issue of *Canadian Hearing Report* marks the initial inclusion of a "Quick Notes" column dedicated to keeping members informed about CAA activities. As I write this, I realize that it is not just growth and internal change that 2009 ushered in, but a host of challenges and wonderful opportunities for the audiology profession.

The direction laid out during our Strategic Planning exercise in February 2009 is pointing us towards truly representing the majority of audiologists in Canada. CAA plans to see the profession flourish beyond historical boundaries to the benefit of all involved as we tackle more strategic areas regarding visibility, collaboration and of course membership growth. Recent activities towards this end include:

- Participation on the Concerned about Classrooms Coalition. The Coalition represents 20 organizations; its goal is to enhance the learning environment of students and the vocal health of teachers in Canada by amending the National Building Code to include classroom acoustic standards;
- Participation in the Canadian Inter-organizational Steering Group for Audiology and Speech-Language Pathology concerned about the practice of audiology and speech-language pathology in Canada. Infection control is its initial project;
- Discussions with the American Academy of Audiology (AAA) about joint ventures for awareness and marketing;
- Collaboration with Federal Healthcare Partners (FHP) – Third Party Payers, First Nations and Inuit Branch of Health Canada (NIHB), Department of National Defense (DND), Royal Canadian Mounted Police (RCMP), Veterans' Affairs Canada (VAC), audiologists and their professional associations to effect positive change for patients/clients;
- A national "Hearing Health Care Initiative"– a collaborative with like-minded professional associations and regulatory bodies spearheaded by the Canadian Hearing Society;
- Our internationally acclaimed conference held recently in Toronto with evidence-based and audiology-focused topics and presentations;
- Our own *Canadian Hearing Report* which is growing to six issues per year in 2010. This will necessitate an aggressive search for articles, and more submissions from the membership of news items, briefs, and clinical reports of interesting cases. Regular book reviews ("From the Library"), "E in ENT", "E for Engineer," and other occasional columns on topics such as the humanitarian efforts of our industry partners, represent some of the fascinating new additions;
- An ambitious marketing campaign to promote the Academy and expand our professional presence within government agencies, universities and colleges, the Canadian auditory industry and the public sector. Tate Marketing is our agency of record, and was selected last summer after a national search to lead our branding and visibility efforts;
- A CAA Survey of audiology practice in Canada, targeting both CAA members, students, and non-member audiologists is currently underway and is considered an integral part of our marketing strategy;
- Promotion of hearing and ear health awareness during National Audiology Week October 19-28, 2009. A number of new audiology promotional "tools" and products have been created and are available on our website.

On the business side of the Academy:

- Our website is being revamped with refreshed content and user friendly links.
- An online Membership Directory will soon provide better access to, and networking for, CAA members.
- We are expanding educational opportunities beyond the Conference to include a Spring Workshop out West … stay tuned.
- We will provide a more meaningful and comprehensive media buy to our corporate partners, suppliers, and manufacturers by integrating Conference sponsorships and exhibit tables with other mutually beneficial opportunities.

Look for a Conference "recap" column in the next issue. Have a terrific fall season!

Tom McFadden,
CAA Executive Director
director@canadianaudiology.ca

As avid readers of *Canadian Hearing Report* (*CHR*) are no doubt aware, Richard Seewald retired in July, 2009, after 37 years as an audiologist, 29 of them spent as a professor of audiology. In this special edition of *CHR*, a few of his former students reflect on the impact Richard has had on them, personally and professionally, as each tries to answer the thought-provoking question: "How has Richard Seewald affected you as an audiologist?" Their thoughtful answers shed light on the wide range of ways a leader in our field can have impact on future generations, both in and out of the classroom. We hope that you enjoy these heartfelt contributions.

Guest Editorial

By Susan Scollie and Lorienne Jenstad

As did many of you, we first met Richard in the classroom. His teaching style exemplified evidence-based practice before there was evidence-based practice. Any budding clinician who had even a glimmer of a geeky side couldn't help but be drawn into his data-driven conclusions, to join him in thinking through the best way to provide hearing aids to people. Perhaps this is what made his teaching so effective – he didn't try to give answers so much as he shared his journey of puzzling through the information. What we received was more process than cookbook. The effects of this resonate in his students, and thus through our field.

Both of us later joined his lab working as research audiologists, rather than working clinically. Little did we know it at the time, but this choice permanently took both of us away from our intended paths toward our own private practices, as we would later enrol in PhD programs and become audiology professors ourselves. If we were to answer the question of how Richard has affected us as audiologists, it would in part be that our entire career paths changed through knowing him. It is difficult to place this profound an effect into only a few words.

Working with Richard gave us a deeper understanding of the person behind the podium. His humility and humanity are so very primary: despite his many successes, his students' opinions of his performance as their teacher have affected him more deeply than any award ever could. Clinicians' stories of even one child being helped by his work hold enough inspiration to sustain him through many more years of worrying over "microdecibels" in a laboratory. This is a man who has remained a clinical audiologist at heart, with his entire academic career spent in service to clinical practice. Through his research and teaching, he tried to make audiology better, by helping audiologists to be better.

Susan Scollie

Lorienne Jenstad

Today, as we stand in front of tomorrow's audiologists, teaching courses that Richard would have taught, we are reminded of his approach, his teaching, his jokes, his stories, his encouragement, his very high standards. For us, the best answer to how Richard has affected our careers as audiologists is that he still is.

Our Contributors

Carolyne Edwards, MClSc, MBA, is director of Auditory Management Services, a longstanding consulting practice in educational audiology for southwestern Ontario, and faculty, Gestalt Institute of Toronto, a centre for personal and professional growth. **Kristen Wheeler**, MClSc, is an audiologist with the Otologic Function Unit at Mount Sinai hospital in Toronto, Ontario. **Lori Leibold**, PhD, is an assistant professor of audiology at the University of North Carolina. **Deb Zelisko**, MClSc, is vice-president, Network Operations, of Lifestyle Hearing, a network of independent hearing health care professionals. **Juliane Shantz**, MClSc, AuD, is an audiologist with the Ear & Hearing Clinic in Kitchener, Ontario, and the

Elmira Wellness Centre & Palmerston Hospital, Elmira, Ontario. **Lorienne Jenstad**, PhD, is an assistant professor of audiology at the University of British Columbia.

CAROLYNE EDWARDS

Carolyne Edwards

Richard and I have been dear friends and colleagues in the field of audiology for so long that I cannot remember how we met. And that seems immaterial at this point.

What was most apparent about Richard from the outset was his warmth, compassion, sense of humour, and appreciation of others. And what emerged was a man of vision in the field of audiology. From a small audiology department at the University of Western Ontario (UWO) in the mid to late 70s has emerged a world-class department, a National Centre for Audiology in Canada and a well-recognized staff who continue Richard's original work in a highly acclaimed laboratory. He said one day that he wanted to see a National Centre for Audiology and so one day, he did. That is vision manifested.

For a man for whom travel is a challenge at times, he has willed himself to travel to many countries around the globe to present his work so that professionals can work with him and so that children with hearing loss will benefit from improved hearing aid fittings. He has attracted a wealth of dedicated hearing professionals who have implemented his work and are waiting for his return to answer their next questions.

In the annual educational audiology seminars that I have held since 1988, Richard was one of the featured speakers for many years and had the rare ability to speak to audiologists and teachers alike and bring to life the most recent trends in amplification and the application of his work to pediatric hearing aid fittings.

When Richard was the head of the department at UWO, he decided to institute some course intensives so that he could bring in a variety of expertise in specific subject areas from outside the department, something that had never been done before but that didn't stop Richard. And so I taught a week-long course in educational audiology – which had never been offered at the university before. This was a rare and delightful opportunity to provide that information in one course and out of that class came several students who went on to become educational audiologists in the field.

Although Richard is best known for his technical contributions to the field, we shared a similar appreciation for the affective aspects of audiology and habilitation. In one of our early conversations, Richard spoke to me about the profound impact of a weekend retreat that was part of a counselling course during his doctoral program at the University of Connecticut. So he supported my interest in bringing fresh perspectives in counselling to UWO audiology students and to the field in general, something that has brought me great satisfaction.

Richard is also an ardent supporter of the human side of audiology. Several years ago I wrote an article entitled "High Tech and High Touch" discussing the merits of the technical side and the affective side of our work. Richard is one of those rare audiologists who encompasses both, evident in his being and how he relates to others. As one of the most well-loved audiologists in the field, there is a reason why. His head and his heart are both very present in his being and in his work.

He is a wonderful image-maker for the next generation of audiologists. We all reflect on our lineage and Richard Seewald's lineage in the field of audiology started with Mark Ross. He has served his teacher well.

KRISTEN WHEELER

Kristen Wheeler

The first thing that comes to mind when one hears the name Dr. Richard Seewald is the audiologist who developed the Desired Sensation Level Method for pediatric hearing aid fittings. His contributions to audiology have been truly remarkable and I feel honoured to know him on both a professional and personal level. In fact, I feel like I knew him before I even met him.

When contemplating at which Canadian university to study audiology, I was strongly encouraged by a pediatric audiologist, with whom I was volunteering at the time, to study at The University of Western Ontario so that I could be taught by Dr. Seewald, the internationally known expert in pediatric audiology. This particular audiologist gave him such a rave review that I truly believed that I'd be crazy not to go to Western! And I'm sure glad I took her advice.

I had the privilege of being enrolled in Dr. Seewald's seminar course in pediatric audiology and also worked under his supervision on a research project for another class. He was a true mentor who demonstrated dedication and compassion in his work. I also got to know Dr. Seewald on a more personal level as he often told stories about his loving family and his life outside of the National Centre for Audiology. His humble and caring nature was as impressive to me as his accomplishments in the audiology world.

Dr. Seewald displayed a contagious enthusiasm for his work, which had a strong impact on my decision to work with infants and children in my own career. Upon graduation, Dr. Seewald played a significant role in my career when he directed me to a position at Mount Sinai Hospital in Toronto, Ontario that would satisfy my desire to work as an audiologist with the Infant Hearing Program. Through his guidance, support, and lessons taught, Dr. Seewald has helped shape my career as an audiologist. Although Dr. Seewald has now retired, his lessons and heart will live on in those whom he taught.

Thank you Dr. Seewald for all that you've done for your students. I wish you all the best in your next chapter in life. Congratulations!

THE INFLUENCE OF DR. RICHARD SEEWALD ON MY CAREER AS AN AUDIOLOGIST

By Lori Leibold


Lori Leibold

Purpose: To answer the following question: "How has Richard Seewald affected me as an audiologist?"

Background: My first introduction to Dr. Richard Seewald was almost 15 years ago as a graduate student entering the audiology program at UWO. From the start of our program, Dr. Seewald stressed the importance of using evidence-based research to guide clinical practice. He challenged his students by emphasizing independent thinking in the classroom. As a result of his instruction, I started to think more critically about the assumptions that underlie the assessment and treatment of infants and children with hearing loss.

I realized towards the end of the audiology program at UWO that I was interested in pursuing further research training. Dr. Seewald was one of the first people I contacted. He provided excellent advice and mentoring during this critical period. Based on his recommendation, I received excellent PhD training at the University of Washington in Seattle, followed by postdoctoral training at Boys Town National Research Hospital in Omaha. I am currently an assistant professor in Speech and Hearing Sciences at The University of North Carolina. Not coincidently, Dr. Seewald has many colleagues and close friends here in beautiful Chapel Hill.

Method: Pretend analyses were performed in a nonrandomized AB time-series design. It was hypothesized that Dr. Richard Seewald has had a significant impact on my career as a researcher and audiologist. The design incorporated a three-year baseline phase (before Dr. Seewald "intervened" and provided advice regarding PhD options) and an 11-year treatment phase (with mentoring from Dr. Seewald). There has been no withdrawal phase – yet!

Results: The results are shown in Figure 1. The top panel shows actual arbitrary performance as a function of time in years. The dashed vertical line indicates the time of intervention from Dr. Seewald (1997). Figure 2 shows predicted arbitrary performance if Dr. Seewald had not intervened in my career. It is obvious from Figure 1 that Dr. Seewald's intervention had a large and positive impact on my career as an audiologist and as a researcher. Performance increased significantly following his intervention.

Discussion: The results of this single-subject design clearly support the hypothesis that Dr. Richard Seewald has significantly influenced my career. Potential limitations of this study are: (1) I don't know anything about single-subject research; and (2) I have now lived on the West Coast, in the Midwest United States, and the South. Note that (2) is also strength because I've met so many great people in my travels.

If you are an audiologist working in Canada you are aware that his contributions to the field of audiology are truly outstanding. His work has been largely responsible for the establishment and adoption of rigorous and evidence-based methods for the selection and verification of pediatric amplification. What may be less obvious is that Dr. Seewald has also created a legacy of clinicians and researchers throughout the world through his teaching and mentorship efforts. Many former students have left UWO to pursue evidence-based excellence in both clinical practice and clinical research. Despite his retirement, this legacy remains and leaves the community of audiology strong and capable.

On a personal note, Dr. Seewald has provided me with consistent and generous career mentoring. He offers a wonderful model of the benefits of training smart and capable students. He is not threatened by the success of others. Instead, he has worked his entire career to identify and promote the strengths of others. It is no coincidence that so many of his former students have

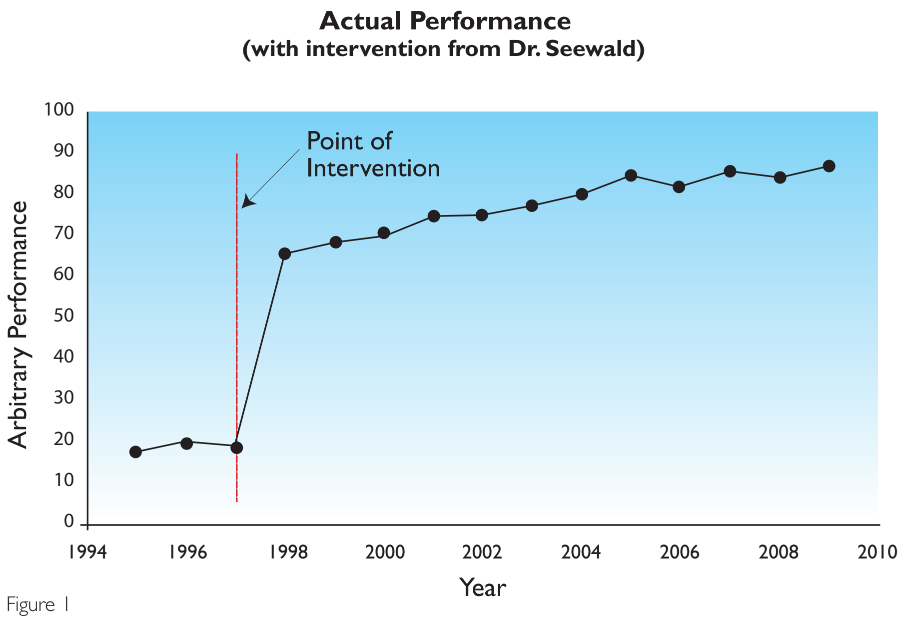


Figure 1

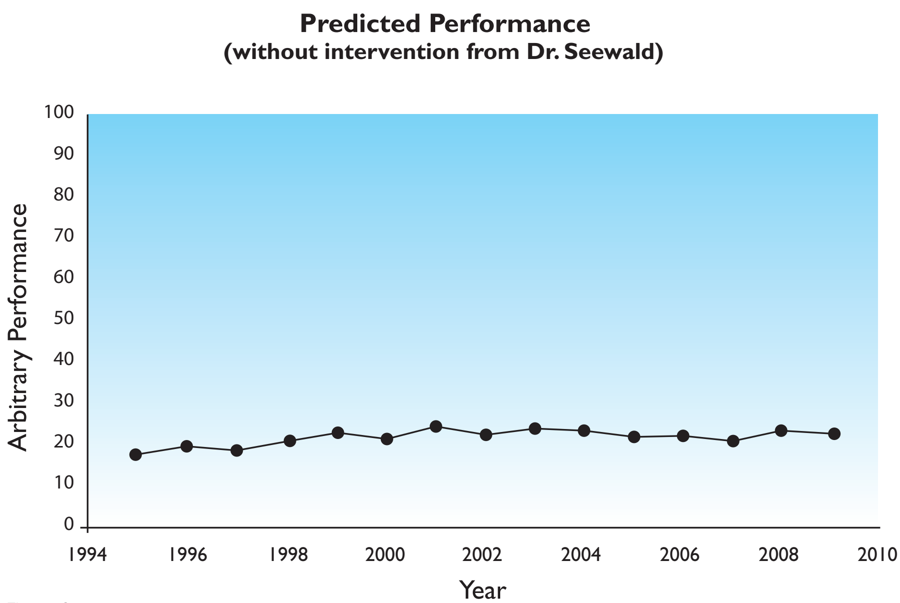


Figure 2

pursued advanced training and have developed independent research programs at both UWO and at universities across North America.

Conclusions: It is obvious that Dr. Seewald has had a significant influence on my career. I wish him the best in his retirement and future plans!

Acknowledgements
Thanks to Drs. Lorienne Jenstad and Susan Scollie for the invitation to contribute to this issue. I am honoured. I also acknowledge that answering this question in the form of a research article is pretty geeky.

DEB ZELISKO

Richard has had a very significant impact on me as an audiologist and a person. I had the pleasure to meet Richard Seewald when I was in my first year of the undergraduate communicative disorders program at the University of Western Ontario (UWO). He walked in one of our clinic laboratories where I was conducting my first otoscopic evaluation on a classmate. He was a very pleasant man even if he was carrying a naked half-torso manikin, which he referred to as "Kemar." I was more focused on the "tumour" I spotted in my friend's ear so the small talk was minimal. The "tumour" turned out to be impacted wax. Richard turned out to be the instructor who taught me some of my favourite classes, my master's level academic advisor, my boss, my mentor, the master of ceremonies at my wedding, my benchmark for the definition of career success, and ultimately my hero. Perhaps that's a lot of different items to credit one man with, but Richard is no ordinary man. Richard is an exceptional individual who has had a profound impact on the field of audiology through his groundbreaking work, his vision for our profession and most importantly the impact he's had on those around him.

Richard's passion for his work and his ability to inspire as he taught helped direct me towards amplification research. Those of us who were his students and were taught the Desired Sensation Level (DSL) approach to fitting children with amplification were so lucky to be imparted with the knowledge first hand; it was only after graduating and being out in the "real world" that I realized just how lucky I was to be taught by one of pediatric audiology's true pioneers.

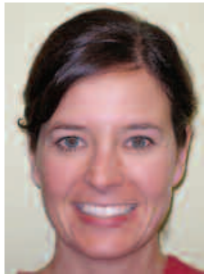
Upon graduation, my work with

Richard continued as I was fortunate enough to work for him for a brief period of time as a research audiologist at UWO. In this capacity I was exposed to visiting opinion leaders and researchers, had opportunities to travel and participate in various conferences, and most importantly, learned more about research and audiology from all of the people at UWO. I also benefited from Richard's advice and input as a mentor and a friend. Richard helped me to appreciate that it's good to ask the questions, not to necessarily be satisfied with the status quo, and that sometimes a new path needs to be taken.

After leaving UWO I was able to stay in contact with Richard in one way or another through various projects and initiatives in my other professional endeavours. I am very fortunate to have worked for Richard this past year in a consulting role. It has been great to reunite with such a wonderful man and such a wonderful team. It has also been a treat to revisit UWO; I am so proud to see what Richard has created with the National Centre for Audiology which he co-founded in 1999. Richard has shown by taking his vision and turning it into reality that there is not just one path in audiology. Audiology is still a very young profession that is continuing to evolve and mature. The need for good hearing health care through audiology is greater than ever; and as audiologists, we all know how we can have a positive impact on someone's quality of life through better hearing. Perhaps my path as an audiologist has not been as conventional and straightforward as others, but the shared vision of how important hearing is for us as human beings and what we can and should contribute as a profession, as well as the resulting direction I have taken is directly related to Richard's teaching, mentoring and guidance.

JULIANE SHANTZ

(Dancing Queen)



Juliane Shantz

I know him as "Dr. Red Pens." It was approximately 12 years ago that Richard scribbled all over my thesis, draft after draft in red, fine-tip ball point pens! I remember those days well; I thought I would be in university forever when all I wanted to do was go out dancing with my classmates at AAA and CAA to avoid working on my thesis. That earned me the nickname "DQ" (Dancing Queen) from Richard and it has stuck ever since.

It was no secret around Elborn College at UWO that Dr. Seewald's area of specialty was pediatrics. I was quite certain that this was the area that I wanted to learn more about, and, specifically with him as my mentor. I knew that he was not accepting students as this was the year he was taking a sabbatical so that he could focus on his own objectives and accomplishments. He definitely deserved to have a year off from students as he always had several on the go. My selfishness took over and I decided to ask him anyway. I remember being nervous trying to find his office door and expecting a straight out decline as he was on sabbatical. Well, much to my surprise, we engaged in a delightful conversation and he said yes! How fantastic for me, not only did the thesis get published but it has turned into a 12-year mentorship experience!

Since finishing at UWO we have met several times to discuss many things, such as: possible curriculum changes for new students, several areas of research, and he encouraged me to carry on with my studies and thus I completed my AuD in 2005. Most recently, we have worked together collecting data for a study titled "Fit to Targets, Preferred Listening Levels, and Self Reported Outcomes for the DSL v5.0a Hearing Aid Prescriptions for Adults" that is soon to be published in the *International Journal of Audiology.*

I truly feel blessed to have Richard as part of my academic life. He has taught me many things. He is absolutely "one of a kind" and a pioneer in audiology. I can't thank him enough for being such a strong influence in my life as I still love going to work every single day!

Well Dr. Red Pens, you are at another crossroad in life. It is time to let go of the hustle and bustle of the academic career that you are used to. It is time to enjoy the simple things like trying to explain to your grandchildren why the stars in the sky sparkle and why no two snowflakes look the same. The profession and I will miss you dearly. Thank you for all that you have done for us!

LORIENNE JENSTAD

Lorienne Jenstad

While working for Richard Seewald as a research audiologist at UWO, I took it upon myself one day to go through some old file boxes in the lab. The treasures I found in those boxes included course notes from classes that Richard had taught throughout the years of his career. I was delighted to find these items for a couple of reasons: first, they revealed something of the way his thinking had (and had not) changed over the years; second, I knew then that I had the beginnings of the tribute I would someday write about Richard. I kept a few gems from those file boxes, and carried them with me from London, Ontario, to Seattle, where I completed my PhD, to Vancouver, BC, where I'm on faculty at UBC's School of Audiology and Speech Sciences. I hoped that I wouldn't have to use those items too soon, but I also looked forward to telling people about the great influence that Richard had on me, both personally and professionally.

I had many wonderful professors during my clinical audiology program, but Richard certainly had a big influence on me and on my thinking. I remember being in his classes and getting a sense of his passion for the people behind the hearing loss. In our first lecture in aural rehab class, he told the story of when he conducted aural rehab sessions as a clinician: he had to run out to the grocery store to buy stir sticks and other supplies for the coffee that would be served, and he stood in the middle of the grocery aisle and said to himself, "Now THIS is what aural rehab is all about!" That story has stayed in my mind all these years, because it embodies so many characteristics of Richard's approach to audiology: compassion for the client, attention to detail, willingness to redefine categories, and of course, recognition of the importance of a good cup of coffee in the rehabilitation process.

The stories of Richard's humour, compassion, and forward thinking are numerous, but let me share just a couple of the ways that Richard has influenced me directly. During my five years of working with him in his lab, Richard encouraged me, helped me to think of myself as smart and capable, and allowed me the freedom to explore my own research questions, while providing his clear and thoughtful guidance. Perhaps his biggest professional gift to me was recognizing when my exploration took me beyond the mandate of his Child Amplification Lab, and suggesting that I pursue PhD studies that would allow me to work with the population that most interested me: vulnerable older adults. I continued to think of Richard as my mentor, even while studying on the other side of the continent, and wouldn't have dreamed of making major study or career decisions without his blessing on my endeavours.

Beyond professional life, Richard was, and continues to be, a big influence to me personally. He taught through his own example and through caring for me and for others that it was okay to "be human." I learned from him the importance of balancing work and life, and also the difficulty of achieving that balance when one is as dedicated as Richard is. I have one of his famous Seewald photographs hanging on the wall over my desk as a reminder of the importance of having passions beyond work, and the importance of seeing beauty and wonder in everyday experiences.

Let me end with one of the items I found in those dusty old file boxes. For anyone who knows Richard's work, the humour of the course outline is instantly apparent, with two weeks of class time dedicated to "Contemporary Methods: Functional Gain." However, I believe this course outline also shows consistency in his thinking: in 1983, he was as dedicated to teaching careful and thoughtful ways of fitting hearing aids, given the tools available at the time, as he was 10 and 20 years later.

Richard, I thank you for your lasting influence on me and on the field of audiology in Canada and around the world.

The Richard C. Seewald Entrance Scholarship in Audiology will be awarded annually to a full-time student entering the first year of the audiology program in the School of Communication Sciences and Disorders at The University of Western Ontario, who demonstrates a strong professional commitment, as well as academic excellence. Preference will be given to the student who demonstrates all-around academic excellence and exceptional potential relating to the practice of clinical audiology. To contribute to the scholarship or for further information, please contact Catherine Dorais-Plesko, The University of Western Ontario, at 519-661-2111x85199 or cdoraisp@uwo.ca.

Course Outline Spring 1983, Richard C. Seewald. Ph.D.

Course Schedule:

Date		Section	Topic
January	5	I	Historical Development of Hearing Aids
January	19	II a,b	Measuring Electroacoustic Characteristics
January	26	II c,d	Electroacoustic Factors
February	2	III a,b	Earmold Impressions and Types
February	9	III c,d	Acoustical Effects of Coupling Systems
February	16	I-III	EXAM
March	2	IV	Hearing Aid Selection: Current Issues
March	9	V	Hearing Aid Selection: Process Overview
March	16	VI	Contemporary Methods: Functional Gain I
March	23	VI	Contemporary Methods: Functional Gain II
March	30	VI	Contemporary Methods: Canal Microphone and Reflex Methods

In the News

SIEMENS HEARING INSTRUMENTS AND THE WALT DISNEY COMPANY HELP CHILDREN DISCOVER THE MAGIC OF BETTER HEARING

Siemens teams with Disney to launch Mickey Mouse-themed hearing care kit for young children with hearing loss —

Siemens Hearing Instruments, together with The Walt Disney Company, are proud to introduce the new Disney Pediatric Kit for children with hearing loss. The kit features a special edition lunchbox with hearing instrument accessories, a plush Mickey Mouse doll and an exclusive Disney storybook about adapting to life with hearing loss.

"Now, the world's most famous set of ears is helping young children learn about hearing loss and cope with their condition," stated Dr. Thomas Powers, vice president of audiology and professional relations at Siemens Hearing Instruments, Inc. (US).

The kit will be made available to Canadian and American audiologists compliments of Siemens, for distribution to all children who are fit with any Siemens hearing instrument appropriate for pediatric use. The kit includes a Mickey Mouse plush doll, hearing aid use and care instruction book, dehumidifier, air puffer, stethoset, tool set, and battery tester. The kit can also be used by children as a lunchbox. The kit will also be accompanied by a new Disney book created exclusively for Siemens, Three Cheers for Bunny's Ears!, which details the adventures of Mickey Mouse and Bunny, a brand new Mickey Mouse Club House character who thrives with hearing loss.

"By teaming up with Disney and Mickey Mouse, one of the most beloved characters in family entertainment, we want to create a meaningful, fun and educational way to connect with pediatric patients and their parents," said Jeff Malpass, Vice President of Sales for Siemens Hearing Instruments in Canada. "We want our audiologists to be seen as a resource and partner for their patients, helping to ease the transition to living with hearing loss by providing children with some familiar characters who are experiencing a similar situation."

www.hearitforthefirsttime.ca

STUDY AIMS TO INCREASE RESEARCH PARTICIPATION OF HEARING IMPAIRED

While the public has made accommodations for 54.4 million people with disabilities, many researchers regularly exclude people who cannot read, hear, or write from participating in their research projects, says Case Western Reserve University.

That's about to change. The Frances Payne Bolton School of Nursing (FPB) at the university will develop research tools and strategies to include individuals with hearing and vision impairments in future research.

www.reuters.com/article/pressRelease/idUS185661+29-Oct-2009+PRN20091029

SAY WHAT?! MUSICIANS HEAR BETTER

Musical training can improve your hearing, according to several studies presented in Chicago at Neuroscience 2009, the annual meeting of the Society for Neuroscience.

The studies found that serious musicians are better than other people at perceiving and remembering sounds. But it's not because they have better ears.

www.npr.org/templates/story/story.php?storyId=113938566&sc=emaf

HEARING LOSS IS COMMON IN PEOPLE WITH DIABETES

Hearing loss is about twice as common in adults with diabetes compared to those who do not have the disease, according to a new study funded by the National Institutes of Health (NIH).

"Hearing loss may be an under-recognized complication of diabetes. As diabetes becomes more common, the disease may become a more significant contributor to hearing loss," said senior author Catherine Cowie, PhD, of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), who suggested that people with diabetes should consider having their hearing tested. "Our study found a strong and consistent link between hearing impairment and diabetes using a number of different outcomes."

www.nih.gov/news/health/jun2008/niddk-16.htm

SEMINARS ON AUDITION 2010

The 25th annual Seminars on Audition featuring Dr. Catherine Palmer, PhD, on Evidenced Based Research and Practice will be held on Saturday February 27, 2010 at the Novotel Mississauga (Toronto area). For more information contact **Marshall.Chasin@rogers.com**.

FDA LAUNCHES NEW ONLINE GUIDE TO HEARING AIDS

"**People who already** use a hearing aid know that selecting the right one is not a simple process," says Eric Mann, M.D., Ph.D., deputy director of FDA's Division of Ophthalmic, Neurological, and Ear, Nose, and Throat Devices. "There are many issues to consider. Also, current users of hearing aids want to know about the latest types and technology, and how to properly maintain the ones they already have."

The site includes sections on

- general information on hearing aids
- types of hearing loss
- types and styles of hearing aids
- how to get a hearing aid
- benefits and safety of hearing aids
- hearing aids and cell phones
- other products and procedures that people can use to improve hearing

www.fda.gov/ForConsumers/ConsumerUpdates/ucm185723.htm

The National Centre for Audiology: Excellence in Hearing Science and Audiological Research at The University of Western Ontario

By Prudence Allen, PhD, Director

The National Centre for Audiology (NCA) is a world class facility for hearing science and audiology research located at the University of Western Ontario.

Officially opened in 2001, the NCA is home to a multidisciplinary group of researchers from several faculties at Western including Health Sciences, Engineering, and the Schulich School of Medicine. The NCA is the largest audiological and hearing science research centre in Canada and one of the largest internationally, serving over 30 principle investigators, research associates, and support personnel.

Through funding from the Canadian Foundation for Innovation, the Ontario Research Fund, and the private sector, the NCA is home to 17 shared and dedicated laboratories that support a wide range of research programs in basic hearing science, diagnostic audiology, and aural rehabilitation. Some unique laboratories include an anechoic chamber and a reverberation chamber providing simulated 3-D environments. Clinically based research in diagnostic audiology is possible in an in-house, state-of-the-art audiological research clinic and an offsite clinic facilitating the study of auditory processing disorders in children. Dedicated laboratories support research in children's hearing development, child amplification, hearing in aging, adult aural rehabilitation, cochlear implants, electrophysiology and brain mapping, auditory biophysics, cortical plasticity, digital signal processing, electroacoustic study of listening and telecommunication devices, hearing device development, and knowledge translation. The NCA Administrative Centre includes several meeting rooms and a library (which includes the Mark Ross Collection) with full video conferencing capabilities.

The NCA provides an integrated, multidisciplinary work environment for a wide range of research projects. One of the greatest strengths of the NCA is the collaborative environment that allows investigators from very different disciplines to come together to address problems and questions in hearing science and clinical audiology. This interdisciplinary collaboration offers unique perspectives and insights into the problems that face hearing health care clinicians, scientists and students, making the NCA a rich and productive environment for conducting research, developing new hearing health care products and forming recommendations for best practices in clinical settings.

The breadth and depth of the research programs at the NCA are impressive. Research areas span the range of infant work to issues surrounding the hearing problems of the aged. Focus in some research programs is highly clinical with immediate applicability and relevance to hearing health care. Other projects have a more basic science focus and seek to support the hearing health care research programs as well as provide knowledge for the sake of the knowledge alone. Projects include human subjects, animal models, computer modeling, electroacoustic verification, and simulations. The research programs are funded by an array of individual and collaborative grants from the federal and provincial governments, foundations and the private sector.

AREAS OF RESEARCH

DIAGNOSTIC AUDIOLOGY

The NCA has a strong program in diagnostics using both behavioural

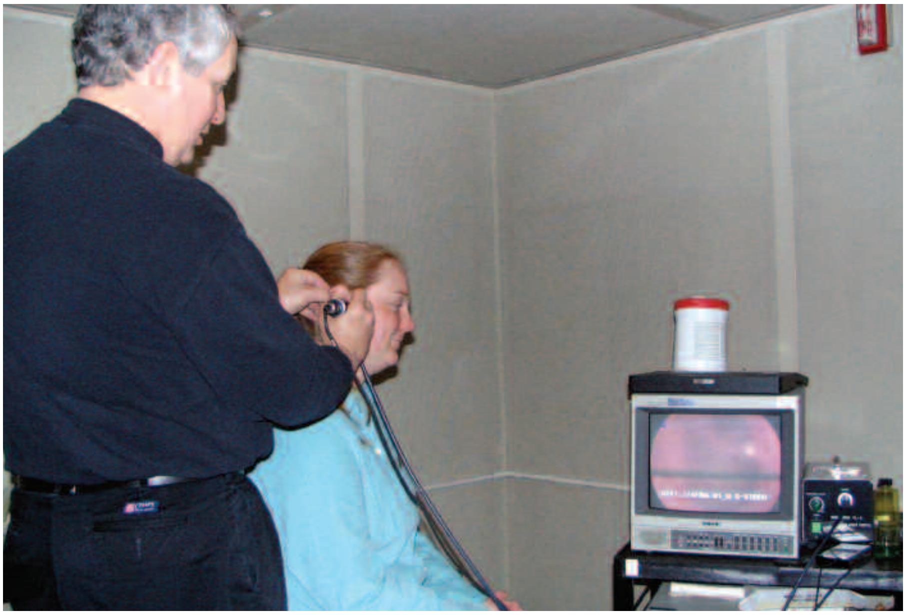
and objective techniques. Research led by Dr. Prudence Allen brings psychoacoustic assessment to pediatric populations enabling study of normal hearing development and auditory processing disorders (APD) in children. Joining forces with Dr. Vijay Parsa's team who have developed a hand held device for field testing, this combined group has brought psychoacoustics out of the laboratory and into the clinic. The group is refining a small handheld tool for psychoacoustic assessment that can be used in the field and, in conjunction with industrial partners, is working on implementation of an audiometer based version of psychoacoustic testing. These new tools and the research that surrounds them, have the potential to bring adaptive psychophysics to clinical populations for use with both children and adults, potentially revolutionizing the way supra-threshold hearing assessment is conducted in the clinic. Dr. David Purcell contributes to the pediatric diagnostic program with his expertise in otoacoustic emissions (OAE) and auditory evoked potentials. His team is improving ways to measure contralateral suppression of OAE's allowing for objective evaluation of outer hair cell and efferent brainstem function and is working on methods to achieve objective verification of behavioural abilities through advanced work in auditory evoked potentials. Rounding out the pediatric work in diagnostics is the work of Dr. Susan Stanton and her team studying genetic factors in pediatric hearing loss, auditory neuropathy, and auditory processing disorders. This team of individuals interested in pediatric diagnostics is working at the NCA laboratories and at a newly formed APD clinic at London Health Sciences Centre-Victoria Hospital where Ms. Chris Allan will lead the team to integrate new diagnostic procedures into clinical care and evaluate the efficacy of these procedures. The work of this multidisciplinary group will bring new understanding of complex auditory processing to clinical care, expand the definition of normal hearing to include not only threshold sensitivity measures but supra-threshold measures of complex processing abilities, and improve the care of children with auditory processing disorders.

A relatively new area of research for the NCA has been in the area of binaural and spatial hearing. Dr. Ewan Macpherson recently joined the NCA and is leading a research program that studies normal sound localization abilities in adults. His work examines the essential cues for sound source localization and the role of head movement in the generation of dynamic cues. His team, joining with Drs. Parsa and Scollie, is also studying the effect of hearing impairment on sound localization and how various assistive listening devices, including hearing aids and cochlear implants can affect functioning in simulated 3-D environments and the perception of sound source localization cues. Initial studies on how children, with and without auditory disorders, localize sound is also a promising new area of research at the NCA. In a new collaboration, NCA researchers will join forces with the Cochlear Implant Team at London Health Sciences Centre-University Hospital, under the direction of Dr. Lorne Parnes, to study the use of spatial hearing cues by patients with cochlear implants.

(RE)HABILITATIVE AUDIOLOGY

In the area of rehabilitative audiology the NCA has a long tradition of excel-

lence. The work in assistive listening devices is unparalleled. Internationally recognized for excellence is the work done by the teams under the supervision of Drs. Richard Seewald and Susan Scollie. The Desired Sensation Level (DSL) Method for fitting hearing aids to infants and young children was developed and continues to be advanced at the NCA. This protocol is commonly chosen as the method which must be used for



fitting hearing aids as part of worldwide initiatives in infant hearing. DSL software has been transferred to more than 25 hearing aid and real-ear system manufacturers globally thanks to the work of Sheila Moodie, Marlene Bagatto, Steve Beaulac, and Jeff Crukley. Their work in assistive listening devices also includes the testing and refinement of new signal processing algorithms. One such example is in the treatment of individuals with high frequency hearing loss who have typically been difficult to fit with traditional hearing aids. A new solution to their needs is frequency compression in which information from the high frequency sounds, where the individual suffers the greatest loss of audibility, is compressed into the lower frequencies where hearing is much better. In clinical trials, led by Danielle Glista, the child amplification team has studied the best way to use this new technology to assist hearing impaired persons and is continuing to study the long term effects of this and other assistive listening technologies on the individual.

In any program seeking to verify the functionality of assistive listening devices, electroacoustic verification is essential. Dr. Parsa and his team bring their engineering expertise to study the electroacoustic characteristics of assistive listening devices in simulated and real auditory environments. They study the effectiveness of noise reduction algorithms and directional microphones. These investigators and practicing clinicians recognize that success with amplification is determined not just by the extent to which the device can improve speech intelligibility, but also by the perceived quality of the instrument. Measures of sound quality have been traditionally made with subjective measures taken from individual listeners. Dr. Parsa and his team have made inroads into defining objective correlates of these subjective measures of sound quality. This work impacts not only on individuals with hearing impairments and the industries that serve them, but also on individuals with normal hearing and industries developing and supplying the telecommunications equipment used daily by nearly everyone.

NCA research programs recognize that success with assistive listening devices is not dependent solely on the device, but on the individual's ability to adapt to and use that device. The device fitting must be integrated within a much larger program of aural rehabilitation. Aural rehabilitation research, particularly with adults, is led by Dr. Mary Beth Jennings. She and her team (Frances Richert, Laya Poost-Foroosh Bataghva, and Christine Meston) are studying the barriers and facilitators to assistive device use and how long term success with devices and other rehabilitation programs can be maximized. This group is also involved, along with colleagues at other Canadian universities, in research in the stigma of acquired hearing loss and vision loss and how mental health may be affected by the presence of a hearing disorder.

Research in (re)habilitative audiology would be incomplete without consideration of the environment in which individuals are asked to listen and communicate. Teams at the NCA, including Drs. Jennings, Margaret Cheesman, and Lynn Shaw are studying hearing accessibility using Universal Design principles developed specifically for the auditory communication environment. This team is asking questions about what makes a good communication environment and how individuals with hearing impairments can seamlessly maintain good communication as they transition between listening spaces. Hearing accessibility research at the NCA studies how well listeners communicate in the workplace, the classroom, and most recently, in vehicles. The first steps are to quantify the communication difficulties encountered by individuals in various environments and then to make recommendations on ways to minimize those difficulties. Similarly, studies on the impact of noise on the hearing of neonates in the NICU and the impact of classroom noise on academic achievement,

round out our understanding of the impact of the environment on hearing and communication. Prevention of hearing loss and hearing conservation are also important areas of research at the NCA. Dr. Cheesman has studied the effect of leisure noise exposure on hearing in children and young adults, and aspects of noise exposure in the NICU, and continues to provide expertise regarding policy and best practices in environmental noise.

AUDITORY NEUROSCIENCE

The NCA also has a strong program of research in the auditory neurosciences spanning the range of work in objective assessment of auditory peripheral and central nervous system function, neuroplasticity, and biomechanics.

Electrophysiological measures of auditory system function and the behavioural correlates of those measures feature as key research areas at the NCA. Early detection of hearing disorders is best achieved by the availability of objective techniques for measuring auditory system function and the knowledge of behavioural correlates of those measures. Work in this area uses techniques such as magneto encephalography (MEG), auditory evoked potentials, and otoacoustic emissions. Dr. Janis Cardy's research team examines the neural correlates of auditory and speech processing in children with autism spectrum disorders and language disorders using MEG and event related potentials.

Dr. Purcell, in addition to his pioneering work in otoacoustic emissions and evoked potentials, is also keenly interested in the interplay between the auditory and speech systems with his studies on the role of auditory feedback on speech production and the extent to which accuracy in production is maintained through self monitoring. Further work in speech perception and production is also an important area of research at the NCA. Dr. Cheesman and her colleagues in the Hearing Science Laboratory are interested in studying the impact of aging on speech perception as well as on other basic auditory abilities.

Dr. Hanif Ladak leads a program of research in the Auditory Biophysics Laboratory studying biomechanics of the middle ear. His team measures mechanical behaviour of the middle ear using techniques in computer modeling, imaging, and laser vibrometry. Along with Dr. Sumit Agrawal, his team is developing interactive computer-based simulations of the middle ear that can be used to simulate disease processes, advance middle ear diagnostics, and assist in surgical preparation. Immersive virtual reality simulators are also being developed to facilitate the training of medical students and surgical residents.

Work led by Dr. Stephen Lomber focuses on studying the plasticity of the central nervous system and the impact of assistive listening devices such as cochlear implants on cortical reorganization. Using brain cooling techniques he developed and an animal model, Dr. Lomber is discovering new facets of brain organization and the plasticity that can accompany hearing and visual impairments and how that may change with rehabilitative interventions. Work in auditory plasticity is also a key feature in the

work of Dr. Scollie and her laboratory as she studies how assistive devices change speech production and the central nervous system during a period of acclimatization to these devices.

Technology Transfer, Knowledge Exchange and Training Opportunities

In addition to the strong emphasis on high quality research and knowledge for the sake of knowledge, the philosophy of NCA researchers is that research should be clinically relevant and applicable. With millions of people worldwide suffering from some form of hearing impairment sufficient to impact on their daily lives, relationships, work and educational opportunities, it is important that our work have impact on prevention, assessment, and remediation of hearing problems. To that end we work closely with our partners in the hearing health care industry including those that develop technologies for assessment and treatment of hearing loss and those that provide services to hearing impaired individuals and their families. Through multisectoral collaborations the NCA brings research questions and results to the community and addresses questions posed by our partners. The NCA has a strong track record in transferring technology to our partners and in providing clinical education, training, support, and policy recommendations to new and practicing professionals, community policy makers and industrial leaders.

The NCA provides an outstanding environment for the training of students, including those interested in careers in research, industry, and clinical practice. Research programs support numerous students in master and doctoral study. These include the Hearing Science Field of the Health and Rehabilitation Sciences program, Engineering, Psychology, Medicine and Neuroscience. The centre also offers a unique opportunity for research experiences to students in the clinical audiology program offered through the Western's School of Communication Sciences and Disorders.

Our research excellence is attributable not only to the work of our principle investigators and their students, but to our excellent support staff and clinical colleagues. These individuals include our administrative officer, Ms. Lucy Kieffer, our software support and IT specialist, Mr. Steve Beaulac, and our technical support specialist, Mr. David Grainger. Our clinical colleagues include Mr. Shane Moodie, Ms. Frances Richert, and Dr. Jack Scott of the H. A. Leeper Speech and Hearing Clinic and Ms. Kim Twitchell and Ms. Kim Zimmerman of the London Health Sciences-University Hospital Cochlear Implant Program. We are also ever grateful to the University of Western Ontario, the Faculty of Health Sciences, the granting councils and foundations, and to our numerous private sector partners for their support.

For more information on research at the National Centre for Audiology please visit us at www.uwo.ca/nca or call to arrange a personal visit (519-661-3901).

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The Audéo portfolio is a collection of tiny and stylish CRT instruments with the power, flexibility and durability to suit virtually every hearing need and individual lifestyle. All three Audéo hearing systems employ the exclusive Phonak SoundRecover to make sure your clients enjoy all the sounds of life. In other words, the hearing instruments offer more than outstanding performance, they are also very attractive and built to last.

Audéo MINI, the smallest Phonak ever, is for clients for whom size and cosmetics are the main issues: it's so tiny and automatic they can just wear it and forget it.

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Desired Sensation Level (DSL) – A Brief Overview

By Lendra Friesen, PhD

One of the most challenging situations pediatric audiologists are confronted with today is the process of hearing aid fitting in infants and young children.

Although the careful selection of electroacoustic properties of hearing aids is important in individuals of all ages, in the pediatric population this procedure is even more critical for several reasons including the inability to adjust the gain control of their hearing aids, or to express preference or displeasure with the sound quality or output characteristics of their hearing aids. These young listeners are therefore forced to listen using the specific hearing aid parameters selected for them. Perhaps the greatest challenge in the selection of hearing aid electroacoustic features in the pediatric population is the limited information available regarding the child's hearing status.

Richard Seewald and colleagues recognized the importance of obtaining precisely and carefully selected electroacoustic parameters in these young children. Consequently the development of the Desired Sensation Level (DSL) method for pediatric hearing instrument fitting began.[1–3] The DSL method is not merely an algorithm for electroacoustic selection but rather a method consisting of sequential stages in a well integrated pediatric hearing instrument fitting process. While developing this fitting technique, it became clear that it was impossible to separate the electroacoustic parameter selection process from the audiometric assessment technique or from verification procedures used in the fitting process. The DSL method therefore includes audiometric assessment, hearing instrument selection, and verification and evaluation of aided auditory performance.[4,5]

Initially, the DSL technique contained a frequency response prescription for children's linear gain hearing aids. The original DSL algorithm recommended target sensation levels for average conversational speech-level inputs per frequency. These targets were based on studies of speech recognition and preferred listening levels. The aim of the DSL prescription was to maximize speech recognition by placing all or most of the 30-dB dynamic range of aided conversational speech signal to a specific target level above threshold. This target calculation was completed on a frequency-by-frequency basis. It was also paired with a prescription of maximum output. A nonlinear version of the DSL method called the DSL input/output formula (DSL[i/o]) was later developed by Cornelisse et al.[6] The main purpose of this version was to restore normalized loudness perception of narrowband stimuli across a wide range of input levels. The nonlinear procedure prescribes basically the same frequency response for average-level inputs as the linear method and provides target input/output plots for narrowband targets, allowing computation of either compression ratios for a given frequency band, or frequency responses per input level.

Using measures of speech intelligibility, loudness measures, and preferred listening levels, the validity of the DSL method for use in children and adolescents with congenital hearing loss has been demonstrated.[7–9] Although originally developed for use with the pediatric population, several studies examining the DSL(i/o) prescription method for use in the adult population have also been conducted.[10–14] Results have varied somewhat, with some positive and other less favourable outcomes in regards to the validity of DSL(i/o) with adults. Generally, studies with less than optimal outcomes reported that DLS(i/o) prescribes too much gain for adult listeners. However using a multidimensional approach, Jenstad et al.[15] conducted a recent study where high and low frequency adjustments relative to DSL(i/o) targets were expressed and a range of optimal hearing aid settings was determined. The empirically derived optimal range was compared to the DSL(i/o) targets to determine whether the DSL(i/o) prescription would result in an optimal fitting. Results indicated that DSL(i/o) targets were within the optimal range for the low frequencies, and slightly above the optimal range for the high frequencies.

The DSL method has risen to the challenge of providing audiometric information regarding hearing status and allowing for the selection of hearing aid electroacoustic features in the pediatric population. This procedure has proven to be valid in the pediatric population and recent evidence suggests that it also holds promise with adults.

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DSL, RECD, and Pediatric Amplification:

Interview with Richard C. Seewald, PhD

Douglas L. Beck, AuD, Web content editor, speaks with Dr. Seewald about desired sensation level (DSL), real ear to coupler difference (RECD), SPLograms, and more.

Academy: Good morning, Richard. Thanks for your time.

Seewald: Hi, Doug. Good to talk with you again.

Academy: Richard, where and when did you get your doctorate?

Seewald: Well, I received my PhD from the University of Connecticut in 1981. I went there to study with Mark Ross to learn more about his work in fitting pre-verbal children with hearing aids. Interestingly, by the time he and I got together he was more interested in educational audiology. So my dissertation looked at auditory and visual speech perception as it related to speech production in school-age children.

Academy: And as that's just about the same time period in which I was getting involved with audiology, I wonder if you had a better way of fitting children with hearing aids than I recall?

Seewald: Well, it was pretty fuzzy then. As a profession, we used the "by the seat of your pants" approach.

Academy: I remember it well. I think it started with a "half-gain" rule and then we just tweaked things from there?

Seewald: Yeah, that's about right. I mean really, all we had was a rough half-gain rule, some really limited hearing aids and little understanding of earmold and ear-canal acoustics, and we just didn't know very much about auditory and speech processing how to measure the outcomes of our interventions with amplification. In retrospect, it was very frustrating as there were no real fitting formulas to apply with infants and children. I thought there must be a better way to do this.

Academy: And so you started working on DSL?

Seewald: Well, yes. We thought there had to be a relationship between the hearing loss and the amount of gain prescribed as a function of frequency. Mark Ross had written an early chapter in the mid-1970s on hearing aid fitting in children, and he was using what we now refer to as "SPLograms" to bring hearing measurements and electroacoustic measurements to the same reference. This was the staring place for our work.

Academy: That was very clever. And just to clarify, in that early chapter in Michael Pollack's book, Mark was trying to standardize input and output, as well as SPL for hearing aids and HL for hearing tests.

Seewald: Right, he was trying to have all the information in the same "language" so that the important interrelationships between all relevant auditory and electroacoustic variables could be studied. I've always thought that we (i.e., audiologists) made the fitting process unnecessarily difficult on ourselves by working in these different scales and domains.

Academy: I agree... but then again, I still argue that we should've transitioned to the metric system decades ago. I can recall signs on the New York State Thruway in kilometers as we tried to transition, before totally giving up a few decades ago. Anyway, yes, it certainly makes sense to use SPL for all hearing and hearing aid measures. In fact, one could argue that audiograms should also have amplitude increase as it rises across the audiogram... but I think these changes are unlikely in our lifetime!

Seewald: You're probably right. Nonetheless, that's why we use SPLograms in DSL, to try to make the amplification fitting process more logical and clear. During my final year in Connecticut, Mark and I started to really work on a new approach to pediatric fitting and to begin to think through what DSL might look like.

Academy: So that was done via paper and pencil at that time... and I guess that must have been in the mid-1980s?

Seewald: Yes, perhaps 1985 or 1986. In addition, we hoped to have a software version soon, but it was not until 1991 when we released the first DSL software and now (2009) we are up to version 5.0.

Academy: And 5.0 has some remarkable new attributes, such as compatibility with toneburst ABR results and different prescriptions for children with congenital hearing loss and adults with acquired impairments. However, I think there are two things that still make people a bit uncomfortable; the SPL scale itself and RECD. Therefore, we have already discussed the SPL issues, so let's talk about "real ear to coupler difference."

Seewald: Sure. Well, Doug, as you know, the 2cc coupler is the standard into which all hearing aid measures start. However, the 2cc coupler is a hard-walled cavity and although it grossly approximates the volume of the adult ear, without actually being identical to the majority of adult ears, the 2cc coupler has very little in common with pediatric ears. The pediatric ear and particularly the newborn's ear is much smaller. If we use hearing aid data based on a 2cc coupler to fit hearing aids to a newborn or a child, the chances are very good that we will grossly over-fit the child.

Academy: And so we need to measure the hearing aid's output in a cavity that resembles the child's ear canal, or preferably, in the ear canal itself.

Seewald: Exactly. Therefore, RECD is just a mathematical correction that allows us to know what we're doing. It allows us to measure the actual SPL in the infant's own ear canal.

Academy: Right, and then we can say if the child has the following thresholds, the SPL needs to so many dB in order for the child to hear the sounds, and then X, Y and Z decibels loud with respect to gain across various input levels, so as to appropriately set compression to maximize the child's dynamic range, without exceeding LDL.

Seewald: That's it. That is all there is to it. And as you know, we always prefer to have RECD measures on each child and each ear, but if that's not possible, we have new norms in DSL 5.0 based on the child's age in months, which are usually in the right ballpark. In other words, they are averages based on age, and they are rarely accurate for a particular child, but they are much closer than the 2cc coupler or average adult values that are often applied in the manufacturer's fitting software. So if for some reason the RECD cannot be measured, we have estimated values based on the child's age. However, using averaged RECD data may still be 12 to 15 dB off, and so very often, averaged data is just not an excellent solution. That is, if you are using averages, you are starting the fitting protocol with a substantial source of error.

Academy: What about ABR data? How is that applied with DSL?

Seewald: We base our ABR-based fittings on some of the work by Dave Stapell and colleagues. So we make frequency-specific corrections from nHL to estimated hearing levels (eHL), which gets us to the audiogram, and then we apply the RECD to go from HL to SPL in the ear canal.

Academy: And I'm pretty sure you need a few different data points, such as tone bursts at 500, 1,000, 2,000 and 4,000 Hz?

Seewald: Yes, frequency-specific threshold estimates are required for accurate hearing instrument fitting in babies. If all we have is a click-based ABR, we just won't proceed with a fitting. It's just not enough information on which to base a hearing aid fitting.

Academy: Yes, that makes sense. What about ASSR?

Seewald: Well the ASSR values are already in the eHL scale, so then you apply RECD and the DSL software system will then predict the SPL at threshold across the measured frequencies.

Academy: What do you recommend for audiologists starting to use DSL?

Seewald: I always recommend that of you have not yet performed RECD measurements, it's best to not start on a child! Let me say that again, it's best to learn the technique with other willing and able adults, so you learn to place the probe mic and get familiar with the hardware and software. It's really fast when you know how to do it, but learning on a child makes it unnecessarily difficult, so start with adults. We measure RECD in some 90 to 95 percent of the babies we see and it usually takes about 3 to 4 minutes from start to finish. It used to take a few minutes for the stimulus, and now it just takes a few seconds once the equipment is in place. So it keeps getting easier.

Academy: Richard, thanks so much. It's been a pleasure speaking with you. Thanks so much for your time and for sharing your knowledge.

Seewald : My pleasure, Doug. Thanks for your interest.

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Fitting Children with the DSL Method

By Richard C. Seewald

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1

We have many different hearing aid fitting procedures to choose from. Why do we need a method specifically for children?

I believe there are sufficient differences between fitting adults and fitting children to justify a comprehensive method designed specifically for the pediatric population. In developing the Desired Sensation Level (DSL) method, we attempted to take into account factors unique to infants and young children in such areas as audiometric assessment, electroacoustic selection, fitting, and verification.

2

What are some of the factors you considered in developing this fitting method for children?

The first major issue is that, at least initially, selection and fitting of amplification are based on relatively limited information. In most cases we begin the selection stage without a detailed description of the child's residual auditory area including frequency-specific measures of thresholds, loudness growth, and discomfort. Also, it is unlikely that we'll be able to engage a 6-month-old in extensive dialogue about his or her listening experiences with amplified sound.

Second, we know that the acoustic properties of the ears of young children differ substantially from those of adults.[1,2] We need to account for these differences at both the audiometric and the electroacoustic fitting stages of the process.

Finally, unlike adults with acquired hearing impairment, infants and young children will be using amplified sound in learning speech and language. Amplification must provide them with adequate access to the speech of others and must also help them in auditory self-monitoring. These are three of the factors we have attempted to account for in developing the DSL method.[3–5]

3

Does the DSL method require me to test hearing in any particular way?

No, the child's thresholds can be measured with a sound field loudspeaker, conventional THD-series, or insert earphones. Although we prefer to use insert earphones for audiometric testing, we've built as much flexibility into the method as possible. That way, if we run into the occasional 12-month-old, for example who doesn't appreciate all the relative advantages of an insert earphone, we have other options available.

4

Why do you prefer to use insert earphones?

Several reasons. First, we've found that children will accept insert phones younger than they will a conventional audiometric headphone. That means we can collect test results for each ear earlier, which is preferable for fitting. Second, we use ear canal sound pressure level in the DSL method to define all the relevant audiometric and electroacoustic variables. We are especially interested in knowing what SPLs are required at or near the ear drum for the child to hear. Some of our studies indicate that the insert earphone, in conjunction with some additional measurements, allows for the best estimate of the ear canal SPL at the child's threshold.[6-8] Finally, by testing hearing this way, we eliminate the real-ear unaided response (REUR) as a factor in audiometric testing. This has some real advantages with young children.

5

What are these "additional" measurements you referred to?

Basically, there are two ways to approach the problem of defining audiometric test findings in the ear canal SPL. You can either measure the quantity you're interested in directly or you can predict it. For direct measurement, you can use a probe microphone to monitor the ear canal SPLs during the hearing test.[6,7] An alternative, which we now use routinely, is to measure the child's thresholds with an insert earphone and also to measure the real-ear-to-2-cc-coupler differences (RECD) for the individual child.

Briefly, we obtain the RECD by measuring the frequency response of the occluded ear canal with a probe microphone and insert earphone. We then deliver the same test signal via the insert earphone into a 20cc coupler; the differences in dB between the real ear and the 2-cc coupler across frequencies define the RECSs for the individual child. For example, if the test signal measured in a 2-cc coupler is 80 dB SPL at 2000 Hz and the same signal measured in a 2-cc coupler is 70 dB, the RECD at 2000 Hz is 10 dB SPL. Because we have calibrated our insert earphone in a 2-cc coupler and have measured the differences in the frequency response between the coupler and the child's ear canal, we can accurately predict the ear canal SPLs at threshold at the relevant frequencies.[8]

Although this may sound complicated, the procedure is quite straightforward and efficient. Most importantly, it gives us precise data to use in selecting the amplification characteristics for each child. This level of precision may be especially critical in working with children (or adults for that matter) who have severe and profound hearing loss and for whom a few decibels one way or the other ca be crucial. I should mention that when we measure thresholds in more conventional ways, or DSL 3.1 software system[9] takes the results and derives the best estimates of the ear canal SPL's for the threshold values that were measured.

6

You're right, this does sound complicated. Are all these different procedures really necessary?

A lot of people ask me that. My working assumption is that young children bring truckloads of variability with them to the fitting process–certainly more that the average adult. For this reason, we need to identify and try to control for all potential sources of error that are associated with our procedures to ensure the optimal fitting. The long-term implications are simply too important to children and their families for us to provide anything less than the best fitting possible.

7

You noted the problem of having incomplete audiometric test results with infants and young children. Can I use the DSL method in conjunction with auditory brainstem response (ABR) test findings?

At least two large pediatric centers have reported successfully using our DSL Version 3.1 software system to select the amplification characteristics of hearing aids on the basis of ABR test results.[10,11] In view of the renewed interest in early identification of hearing impairment, there is an urgent need to develop a more valid and systematic linage between the diagnosis of hearing impairment and our intervention strategies.

8

You've mentioned the DSL software system several times. How does it work?

The DSL method is now fully implemented in a PC-based software system.[9] The software system facilitates the fitting process in several ways. First, it performs all the calculations required with the DSL method. For example, once you've entered the child's threshold and RECD values, the program calculates several sets of target values for real-ear hearing aid performance, including: (1) the desired sensation levels (DSLs) for amplified speech; (2) target real-ear aided response (REAR) and real-ear saturation response (RESR) values; and (3) target-aided sound-field thresholds.

In addition, once you've selected a particular hearing aid type, the program calculates the desired 2-cc coupler gain and SSPL characteristics for the child under consideration. The program also allows the user to graph the unaided and aided results in what we refer to as an SPL-O-GRAM format, as opposed to a conventional audiogram. Finally, the program will print a hard copy of a client record and a hearing aid recommendation form. In response to a number of requests, we are just now completing a version of our software system that will operate on Macintosh computers.

9

Your answer raises several questions I want to get back to. But first, can I use this method without your computer program?

Yes you can, although not as efficiently. Before we designed the software system we used the DSL method with a look-up table in our clinic. We've also developed a set of materials for persons who want to use the DSL method but don't have access to a computer. For information on the software system and the "by-hand" version of the DSL method, contact: Sheila T. Sinclair, Research Audiologist, Hearing Health Care Research Unit, Elborn College, The University of Western Ontario, London, Ontario Canada, N6G 1H1.

10

You said that the threshold and the RECD values had to be entered into the computer program. But sometimes it simply isn't possible to measure the RECD. Does this mean the program can't be used?

No, it doesn't. Because the RECD is such an important variable in fitting children, we recommend measuring it whenever possible. However, when you can't enter RECD values, the software system calculates the child's age and applies age-appropriate RECD values for all subsequent calculations. Because the DSL method is designed for children, we have built as much flexibility as possible into the system. The only requirement for the computer program to operate is that a threshold value must be entered for at least one frequency region.

11

Exactly how is a child's RECD measurement used in your fitting method?

We apply RECD values at two stages in the process. As I mentioned, when we use an insert earphone in audiometric testing, the RECD values help us predict what SPLs we need to put in the child's ear canal for the child to hear. Because we're working toward the aided condition, we're most interested in knowing what SPLs are required in the ear canal for the child to hear amplified sound. We must always remember our purpose in doing the measurement and the various assumptions associated with the procedures we use.

For example, when we calibrate the output of an insert earphone in a 2-cc coupler for 0 dB HL, average normal hearing sensitivity, the calibration values we apply assume we are testing someone with an average adult external and middle ear. But, infants and young children do not come with average adult ears, so we need to account for these differences in deriving our prediction of the ear canal SPL at threshold. The measured RECD values are used for this purpose.

Second, the RECD values are applied at the electroacoutic fitting stage. We recently described this application in detail.[12] Briefly, in the DSL method we decide first what the frequency/gain and output-limiting characteristics of a hearing aid should be in terms of real-ear performance, we then apply the RECD values in developing the desired 2-cc coupler characteristics for gain and for output limiting.

There are several advantages to this approach with young children. First, we account for the individual child's ear and earmold acoustics. Second, having defined the acoustic difference between the real ear and the coupler, we can perform all electroacoustic response shaping in the highly controlled acoustic conditions of the hearing aid test box and have a very accurate prediction of how the hearing aid will perform when it has been fitted to the child.[13] This is a real plus in working with this delightful, yet not always cooperative patient population.

12

This all sounds very scientific, but I'm still not convinced I need to measure the RECD for each child I see. Just how much difference is there between the RECDs for a young child and for a typical adult?

The excellent group at the Boys Town National Research Hospital has reported some very informative data on this topic.[9] In our clinic we've found that RECD values for infants and young children can be as much as 20 dB greater than average adult values. Here's an example of what this can mean. The SSPL of a hearing aid is measured to be 115 dB SPL in a 2-cc coupler at 4000 Hz. In the average adult ear, this would translate to an SPL of approximately 122 DB, because the average adult RECD is approximately 7 dB at this frequency. In contrast, the same hearing aid fitted to the ear of a 6-month-old child could produce a real-ear output as high as 142 dB, simply because of the acoustic properties of the external ear canal. We should know this in fitting children.[14]

13

Is your method designed only for behind-the-ear fittings?

No. Before the software system calculates the desired 2-cc coupler requirements, it asks which type of hearing aid you'll be fitting. The options are: body-type, behind-the-ear, in-the-ear, and in-the-canal instruments. Depending on which you select, the program retrieves the appropriate set of microphone location effect values and applies them in deriving the desired 2-cc coupler response characteristics.

14

Can I use the DSL method in fitting other devices for children such as FM systems?

Yes, this method is not device-specific. Our general approach to fitting an FM system is first to obtain the best fitting possible with the child's hearing aid. Then we apply a specific set of electroacoustic procedures to ensure consistency in the output between the hearing aid alone and the FM-system conditions. Several articles and book chapeters[15–17] as well as the recently published ASHA Guidelines[18] offer details of this approach to fitting FM systems.

15

Why does the DSL method prescribe so much more high-frequency gain than some other prescriptive procedures?

Your question brings us back to the importance of auditory self-monitoring for children. Young children will use amplified speech in the all-important process of learning to speak. It is as necessary for them to hear their own speech as to hear the speech of their conversational partners.

A few years ago, we measured speech levels of normal-hearing children at their own earl level (the position of a hearing aid microphone).[19] We found that at frequencies about 2000 Hz the children's own speech levels were lower than the levels of average conversational speech that are recommended for fitting hearing aids in adults.[20] This is because the unvoiced, high-frequency consonant sounds of speech are highly directional and do not "bend around the head" as much as the lower-frequency, voiced speech sounds. That means we have to give a young child somewhat greater high-frequency gain if he is to hear his own attempts at producing high-frequency consonant sounds.

16

Why do you display the fitting results on a graph you call an SPL-O-GRAM rather than on the more conventional audiogram?

First, the idea of graphing the results of our testing in dB SPL isn't new. Several others have recommended this approach including Norm Erber and Mark Ross in the 1970s.[21,22] The major advantage is that by plotting all relevant audiometric, acoustic, and electroacoustic variables on one graph, you can compare them directly to each other. Actually the dB SPLs you use can be those measured in either a 2-cc coupler or in the real ear. What's most important is to use a common point of reference in plotting the predicted or measured levels of all relevant variables on the graph. This enables you to easily see the relationship between, for example, an audiometric variable such as the loudness discomfort level and the most relevant electroacoustic variable, in this case the saturation response of the hearing aid. In this way you eliminate the "apples and oranges" problem of measuring hearing in dB HL and hearing aid performance in dB SPL.

17

Don't parents find all this confusing or difficult to understand?

Yes and no. Parents who are accustomed to seeing aided and unaided thresholds plotted on a conventional audiogram do require a little time to make the conception shift from dB HL to dB SPL. However, we've designed the graphing function in the computer program so that each variable plotted can be introduced sequentially, one at a time, to facilitate counselling. Parents of newly identified children seem to have little difficulty understanding the information plotted in our graphic displays. Having used this approach for several years, we feel the SPL-O-GRAM provides a more complete and more accurate description of the factors that have been considered in fitting amplification.

18

Why isn't DSL a prescription procedure option in any of the commercially available probe-microphone systems?

Perhaps the major reason is the relative complexity of the method. Recall that this software system does a lot of work on the audiometric data to predict the ear canal levels at threshold before the desired real-ear electroacoustic characteristics are selected. Where possible we have tried to eliminate the use of average adult values in the method. We hope these efforts will lead to more individualized fittings with children. The down side is that computational complexity increases substantially.

I've spoken with several manufacturers of probe-microphone systems to explore the possibilities for implementing the DSL method and I'm pleased to report that a full implementation of DSL will be available on the Audioscan system very soon.

19

Is there anything else in the works?

Perhaps the major development is the new version of the DSL method we've designed for fitting full-dynamic-range-compression instruments.[23] Currently, we refer to it as the DSL input/output or DSL[i/o] but I expect it to evolve into Version 4.0. Its advantages are that it is not instrument-specific and doesn't require you to make supra-threshold loudness judgments. When such measures have been obtained (for older children and adults), the results of the loudness measures will be applied in deriving the prescription. The Hearing Journal will have an article on this version in an upcoming issue.

20

Finally, why do you believe it's so important to apply a prescriptive approach in fitting hearing aids in children?

First, let me say that, ultimately, I would like to see us, as a profession, apply a more uniform and valid approach to this particular population. At present, the same child can see five different hearing health care professionals and leave with five different prescriptions for amplification.

I'm not claiming that any of the prescriptive methods now available, including the DSL method will lead to perfect fittings in every case. In my opinion, none has evolved to that level of sophistication. However, my concern is that if a professional chooses not to use a formal prescription procedure, or at least some procedure whose rationale is stated and whose specifics are explained, then what is the alternative?

In fact, one could argue that it is more important to apply a systematic prescriptive procedure with young children than with any other population. That's because at least among infants and preschool children, most will have no control over the amplification they are expected to live and learn with. For this reason alone, it is critical that our profession move toward a more valid, uniform and defensible approach to this challenging problem.

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Selecting Amplification Characteristics for Young Hearing-Impaired Children

By Richard C. Seewald, Mark Ross, and Mark K. Spiro

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ABSTRACT

The task of selecting the electroacoustic characteristics of hearing aids for young hearing-impaired children continues to challenge many clinical audiologists. The rationale for a theoretically based approach to this problem is presented. Additionally, issues related to the choice of an idealized speech spectrum for a theoretical selection model are considered in relation to the acoustic environment and auditory needs of young hearing-impaired children. Finally, the preliminary version of a computer assisted speech spectrum approach, which facilitates the initial selection of frequency/gain and frequency/SSPL characteristics is presented.

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Selecting Amplification Characteristics for Young Hearing-Impaired Children

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ABSTRACT

The task of selecting the electroacoustic characteristics of hearing aids for young hearing-impaired children continues to challenge many clinical audiologists. The rationale for a theoretically based approach to this problem is presented. Additionally, issues related to the choice of an idealized speech spectrum for a theoretical selection model are considered in relation to the acoustic environment and auditory needs of young hearing-impaired children. Finally, the preliminary version of a computer assisted speech spectrum approach, which facilitates the initial selection of frequency/gain and frequency/SSPL characteristics is presented.

The selection of amplification characteristics for preverbal hearing-impaired children is one of the most challenging problems confronting clinical audiologists. First, preverbal children do not have the ability to adjust the gain control of their hearing aids to a comfortable setting depending upon the acoustic conditions they encounter. Additionally, they are unable to express preference for a particular frequency response on the basis of the intelligibility or quality of their auditory experience. Finally, other than by quite skillfully removing them from their ears, preverbal children have no other means of communicating their displeasure with the selection of the output characteristics of their hearing aids. Thus, in terms of electroacoustic characteristics, preverbal hearing-impaired children are basically forced to live with what we give them. With this in mind, it is clear that the electroacoustic characteristics of hearing aids must be selected systematically, and with the utmost care and precision. The real challenge lies in the fact that this very precise selection is based on extremely limited information regarding the child's unique auditory characteristics.

During the past 8 to 10 yrs we have witnessed a renewed interest in issues related to amplification for the hearing impaired. We most certainly know more now than we did 10 yrs ago regarding the acoustic, electroacoustic, and psychoacoustic factors related to this clinical problem.[1,34,35] Yet, for children, we find ourselves restating Schwartz and Larson's[31] observation that ". . . there is presently no preferred method for selecting the hearing aid that will provide optimal benefit."

In approaching this problem we agree with the position taken by Byrne,[5,6] that the initial selection of amplification characteristics must be viewed as a theoretically based process. A theoretical approach, as proposed by Byrne, bases selection upon known or hypothesized relationships between the amplification characteristics of hearing aids and the measurable auditory characteristics of specific individuals. The result of this theoretical approach is a specific set of electroacoustic characteristics which the theoretical model predicts as being most appropriate for the individual. The validity of the prescribed set of electroacoustic characteristics will of course be only as good as the validity of the theoretical model upon which its selection is based. Despite this limitation, the theoretical approach appears preferable to an empirically based trial and error method for which the validity of any selection is only as good as an individual clinician's ability to select specific characteristics from an essentially infinite set of options.[6]

It is our intent to develop a theoretical computer assisted approach to the initial selection of amplification characteristics for preverbal hearing-impaired children which reflects current knowledge and is realistic in terms of standard clinical practice. In addressing this problem we acknowledge that there is currently no method of proven validity or reliability for directly quantifying suprathreshold dimensions of auditory perception in preverbal hearing-impaired children. Thus, any method for selecting electroacoustic parameters has to be based primarily upon audiometric threshold data. Second, it is believed that any approach to this problem must somehow account for the fact that the real-ear performance of a hearing aid can differ markedly and is unpredictable from its electroacoustic performance characteristics as defined in a standard 2 cm^3 coupler.[17–19,21,37]

To be realistic in terms of routine clinical practice, we believe that instrumentation requirements should reflect the current situation found in most audiological settings.

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To be realistic in terms of routine clinical practice, we believe that instrumentation requirements should reflect the current situation found in most audiological settings. Thus, all that is required is the instrumentation capability for performing frequency specific soundfield audiometric measurements and electroacoustic measurements of hearing aid performance. Finally, we acknowledge that most clinical audiologists obtain audiometric data in decibels Hearing Level (HL) and hearing aid electroacoustic performance data in decibels Sound Pressure Level (SPL). Rather than ignore conventional practice, our computer program has been written such that all audiometric data can be entered in dB HL, and all hearing aid electroacoustic data can be entered in dB SPL as defined in the 2cm^3 coupler.

The general approach we have chosen to take with young children might best be described as a speech spectrum based procedure.[7,14,16,29,30] The goal is to select frequency/gain characteristics which place the amplified speech spectrum somewhere between the threshold of audibility and Loudness Discomfort Level (LDL) within each of several selected frequency regions. One major advantage of this approach is that it provides an estimate of the sensation levels at which speech will be received as a function of frequency. Such information should be useful in the design and implementation of the habilitation programs for young children.

All speech spectrum based approaches reported in the literature have chosen a best approximation of average conversational speech in terms of an idealized speech spectrum.[2,4,8,11,16,27,32,33] Obviously, the way in which the speech spectrum is operationally defined will have a direct effect upon the resulting electroacoustic characteristics predicted as appropriate by the selection model[3] For example, the greater the level of speech as represented by the idealized spectrum, the lower will be the predicted gain requirements.

There are two specific issues which are especially relevant to the selection of amplification characteristics for preverbal hearing-impaired children. First, the relationship between distance and the resulting speech spectrum which reaches the microphone of the hearing aid must be considered. A recent study by Turner and Holte[36] serves to illustrate how the speech spectrum varies as a function of distance. Using five female talkers, their study compared the average speech spectrum as measured with a microphone 20 cm below the mouth with spectrum measurements obtained at a distance of 1 m. The intensity of speech, within each of six 3rd-octave bands, was found to be 14 to 21 dB greater at the nearer 20 cm position. As we consider the communicative environment of young hearing-impaired children, particularly the mother-child interaction, we often find the child in close proximity to the source of speech. Thus, the relationship between distance and speech spectrum characteristics as it pertains to the young hearing-impaired child must be accounted for in the selection of an idealized spectrum of speech.

Second, in view of the important role the process of auditory self-monitoring plays for children who are learning to produce oral language,[15] we must be equally concerned with the spectrum characteristics associated with the child's own speech productions. In effect, the selection of the idealized speech spectrum must account for the complete role audition plays for the preverbal child.

A review of methods which use idealized speech spectra for selecting amplification characteristics reveals substantial differences regarding the way in which the spectrum is defined. In view of the above considerations related to distance and auditory self-monitoring, we have chosen to use the idealized spectrum described by Cox.[11] With an overall long-term RMS value of 70 dB SPL, the one-third octave band levels represented by this spectrum are among the highest reported in the literature.

THE SELECTION PROCEDURE

Along the lines of Byrne's' conceptualization of the selection process, this preliminary version of our computer assisted approach includes four sequential stages: (1) specification of electroacoustic characteristics predicted to be appropriate for auditory threshold data; (2) selection of a hearing aid and earmold coupling system which should provide the best electroacoustic approximation to the predicted specifications; (3) measurement of real-ear performance, in terms of functional gain, with the selected hearing aid and earmold; and (4) modification, if indicated, of the preliminary selection as based upon observed differences between predicted and real-ear performance. With this basic structure in mind, the following provides an overview of the selection process in its current form through the use of a simulated case example.

STAGE I. SPECIFICATION OF ELECTROACOUSTIC CHARACTERISTICS

The first step in the process is to obtain frequency specific sound field audiometric thresholds at as many as possible of the octave and interoctave frequencies between 250 and 6000 Hz. In general, our sound field measurement procedures and SPL reference values for frequency modulated tones conform to those as recommended by Morgan et al.[25] At this stage, the threshold data are entered into the computer for those frequency regions at which measurements were obtained. A series of calculations is performed by the computer and the predicted electroacoustic characteristics including frequency/gain and frequency/SSPL functions as well as target aided sound field thresholds, are printed for future reference. In addition to the decibel HL to decibel SPL conversion factors[25] and idealized speech spectrum values,[11] the following information is stored within the computer's memory:

1. Desired Sensational Levels for amplified speech as a function of hearing level and frequency region and,
2. Desired Saturation Sound Pressure Levels as a function of the predicted level of amplified speech.

Desired Sensation Levels

The desired SLs of amplified speech are determined by nonlinear equations derived for the curves shown in Figure 1. On the basis of these curves, the computer program calculates the level above threshold that amplified speech should be placed as a function of HL for each frequency for which threshold data were obtained. For an individual with a 20 dB HL at 1000 Hz, for example, a desired SL of approximately 30 dB is selected for the 1000 Hz region. Likewise, for an individual with a 20 dB HL at 6000 Hz, a desired SL of approximately 20 dB is selected for that particular frequency region. It can be observed that for all frequencies, the desired SL of amplified speech decreases in an accelerated nonlinear fashion with increasing HL.

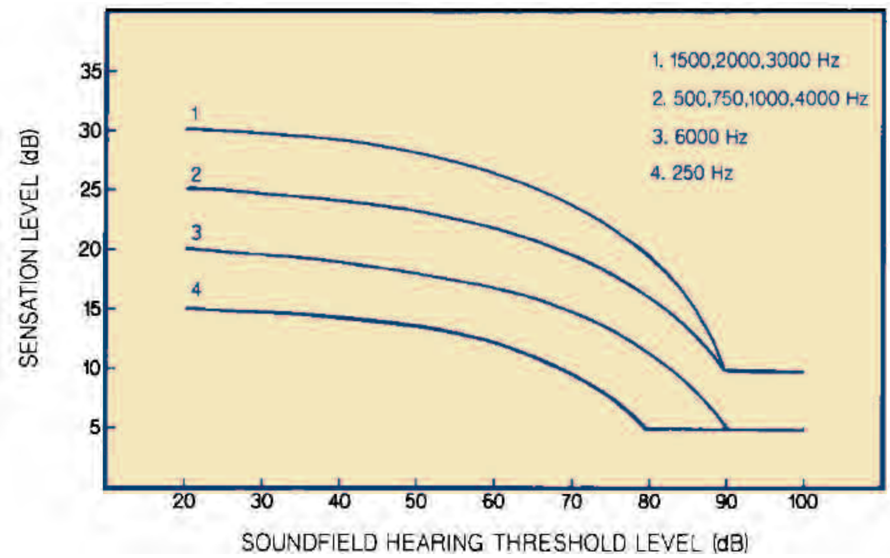

Figure 1. Desired sensation levels (dB) as a function of hearing threshold level (dB HL) and frequency region.

The relative weighting of desired SLs, as a function of frequency, was initially based upon Pascoe's[27] "two humped" distribution of normal sensation levels. After running a series of computer simulations, we became concerned that a sensation level emphasis within the 500 Hz region would be inappropriate for many of the hearing-impaired children we see for whom upward spread of masking effects are of some concern.[13] Thus, the current version of our program selects a slight emphasis in aided SL between 1500 and 3000 Hz only. Otherwise, we have maintained the general contour of Pascoe's distribution of sensation levels.

To date we have only limited knowledge regarding the optimal relationship between HL and the SL of amplified speech." Studies which have examined the relationship between degree of hearing loss and preferred listening levels for individuals with sensorineural hearing loss have demonstrated a fair degree of intersubject variability with standard errors on the order of 7 to 9 dB.[7,12,23,24] A number of these studies,[7,23,24] have developed empirically based equations for predicting preferred aided sensation levels as a function of HL. As Cox[10] has pointed out, however, these studies have had a sufficient number of methodological difficulties associated with them such that the validity of their frequency specific predictive equations remains open to question.

Our equations for the desired SLs of amplified speech are not strictly based upon any specific data set. Rather, they reflect a general goal to present the range of intensities associated with speech sufficiently above threshold to be useful, yet simultaneously considering limitations imposed by the reduced residual hearing area associated with increasing degrees of sensorineural hearing loss.[22] Obviously the validity of the desired SLs will need to be tested.

Desired Saturation Sound Pressure Levels

The selection of an appropriate real ear SSPL can be viewed as a compromise. On one hand, the SSPL should be sufficiently high such that the amplified speech levels do not exceed the saturation level more often than not. On the other hand, the SSPL should not be so high as to permit the levels of amplified speech to exceed the child's LDL. In view of the fact that we cannot obtain a valid measure of the preverbal child's LDL as a function of frequency, nor can we predict LDLs with any reasonable degree of accuracy from auditory threshold data,[20] we have chosen to select the desired real-ear SSPL values on the basis of the predicted signal levels of amplified speech.

The relationship between the predicted levels of amplified speech and the desired real-ear SSPL is shown in Figure 2. It can be observed that the difference in dB, between the predicted amplified signal level and the desired real-ear SSPL, decreases with increasing signal level. For example, if the predicted signal level is 60 dB SPL, the computer program selects a real-ear SSPL of 97 dB as desirable thus providing a difference of 37 dB. In contrast, if the predicted level of amplified speech is 110 dB SPL, a desired real-ear SSPL of 123 is selected providing a difference of only 13 dB between the two. Although the selection of the desired real-ear SSPL is based directly upon the predicted signal levels, all SSPL values selected by this program fall below the median LDL values for degree of hearing loss categories described by Kamm et a1.[20] As well, the SSPL values fall within the general guidelines for output limiting with children as recommended by Rintleman and Bess.[28]

Figure 3 presents some of the information which has been stored, entered, and computed at the first stage of the selection process. Specifically, this figure presents the long-term average RMS speech spectrum which has been stored within the computer's memory. Second, the auditory threshold data as entered in

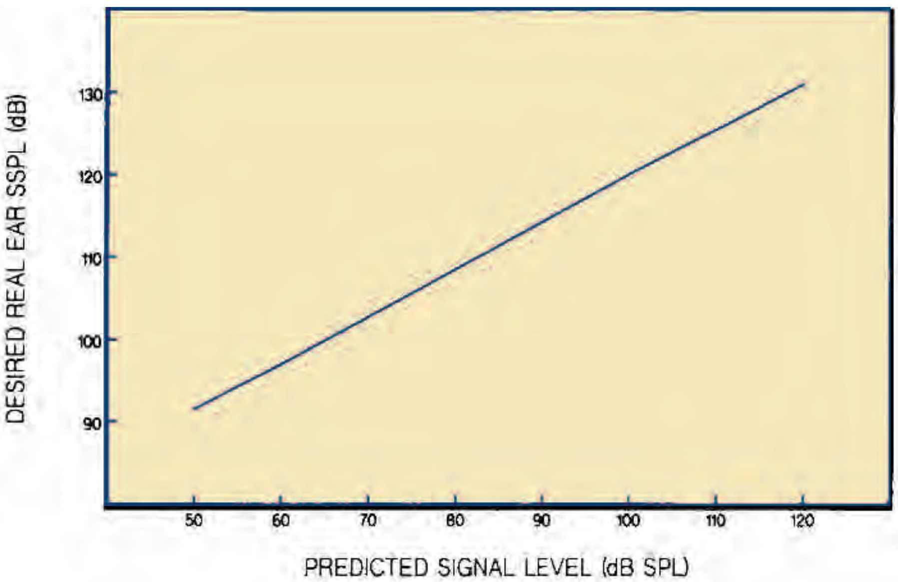

Figure 2. The linear function for the relationship between the predictedsignal level of amplified speech in dB (SPL) and the desired real ear SSPL.

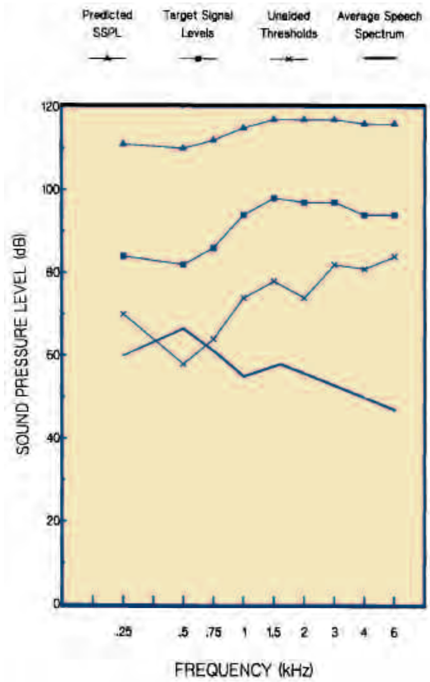

Figure 3. Monaural unaided sound field thresholds, target amplified signal levels, and desired real-ear SSPL in dB SPL as a function of frequency for the case example. The idealized speech spectrum is also shown.

dB HL and converted to dB SPL are also shown. Finally, the target levels at which the idealized speech spectrum is to be placed along with the desired frequency/SSPL levels are presented. One important component of the computer's output which is not presented in this figure is the predicted frequency/gain function. The predicted gain values by frequency reflect the difference, in dB, between the level of the idealized spectrum and the target signal levels for amplified speech. Stated differently, the program determines, for each of nine frequency regions, the amount of gain required to place the idealized speech spectrum at the desired SLs for amplified speech.

STAGE II. SELECTION OF HEARING AID/EARMOLD

At the second stage of the selection process, a hearing aid and custom earmold coupling system are chosen which, at least in theory, will provide the best approximation to the frequency/gain and frequency/SSPL functions derived in stage I. With a preselected "use gain" setting taped into place, both frequency/gain and frequency/$SSPL_{90}$ electroacoustic characteristics are measured in a 2 cm^3 coupler and recorded for future reference.

STAGE III. MEASUREMENT OF REAL-EAR PERFORMANCE

At the third stage of the process, the adequacy of the initial selection is evaluated by means of functional gain measures. Specifically, the hearing aid and custom earmold coupling system are fitted to the child with the gain control set precisely as it was during the electroacoustic analysis. In addition, the measurement conditions under which the unaided sound field thresholds were obtained are replicated for the aided measurements.

Figure 4 presents the unaided thresholds, target signal levels for amplified speech, and target thresholds in dB SPL. All of this information is generated by the computer at stage I. In addition, for those who prefer to view audiometric data on the standard audiogram, the computer provides both the target signal levels and target thresholds in dB HL as well. If the frequency/gain function, as defined in

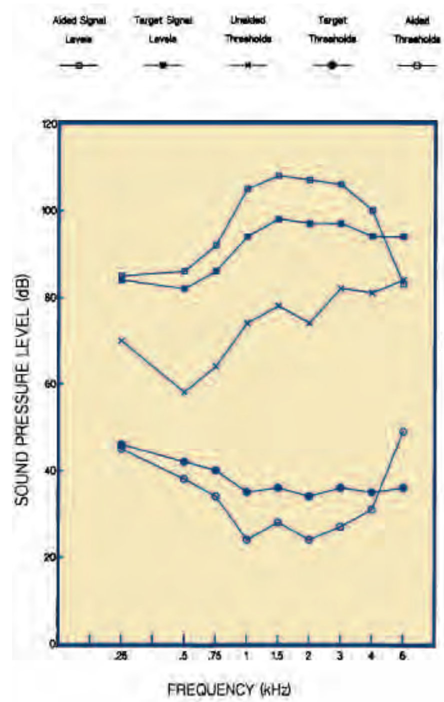

Figure 4. Monaural unaided sound field thresholds, target amplified signal levels, and target aided thresholds in dB SPL. The aided thresholds and predicted real-ear levels of the amplified idealized spectrum are also shown.

the 2 cm[3] coupler, and earmold coupling system produce the desired gain in the real-ear, the sound field thresholds obtained with the hearing aid in place will match the target threshold values shown in this figure.

At the third stage, the aided sound field thresholds, in dB hL, are entered into the computer. In the lower portion of Figure 4, the extent to which the aided thresholds deviate from the target values is shown. It can be seen that the target and aided sound field thresholds agree relatively well at 250 and 4000 Hz. However, these results suggest that too much real-ear gain is present at the majority of audiometric frequencies with too little gain at 6000 Hz. These differences observed between the target threshold values and aided thresholds reflect any near field effects such as head baffle and diffraction and/or effects of earmold or ear canal acoustics in addition to any coupler versus desired frequency/gain differences.

The hypothetical result of this mismatch between desired and functional gain can be seen in the upper portion of Figure 4 in terms of the aided versus target signal levels of amplified speech. As shown here, excessive real-ear gain, particularly within the 1000 to 3000 Hz region, results in signal levels of amplified speech exceeding target levels by as much as 11 dB. Finally, it is noted that the amount of functional gain provided by this hearing aid and earmold at 6000 Hz is insufficient to place the idealized speech spectrum above auditory threshold.

STAGE IV. MODIFICATION OF THE PRELIMINARY SELECTION

As determined at the previous stage, the amount of real ear gain, as reflected by the aided thresholds, differed from the target values at most of the audiometric frequencies. Thus, a modification of the frequency/gain characteristics is indicated.

At the fourth and final stage of the selection process, the coupler gain values are entered into the computer. With this information the computer can determine the corrected frequency/gain function which will provide the desired amount of real-ear gain for the individual. As shown in Table 1, the computer program subtracts the functional gain/desired gain difference (line 2) from the coupler gain values (line l), at each frequency. The result, labeled desired coupler gain (line 3), is the frequency/gain function needed in the coupler to produce the desired amount of gain in the real-ear. At 1000 Hz, for example, the program determined that the amount of real-ear gain exceeded the desired amount by 11 dB. By subtracting this amount from the actual coupler gain at 1000 Hz, we find that a coupler gain of 31 dB rather than the original 42 dB is indicated. At this point, then, the frequency/gain function of the hearing aid is modified to meet, as closely as possible, the desired coupler gain values.

In view of the specific population we have chosen to focus on, the real-ear effects, including earmold and ear canal factors, on the frequency/SSPL function are of critical importance.[17] With young children in particular, with their relatively small ear canals, there is every reason to expect that the 2 cm[3] coupler will generally underestimate the sound pressure a hearing aid produces in an ear canal.[19] Until insertion gain measurements become incorporated into routine clinical practice,[26] we have decided to take the following approach to this problem. As shown in Table 2, the program takes the real-ear gain/coupler gain difference in dB (line 2) at each frequency and subtracts this difference from the desired real-ear SSPL (line 1). In this way, the coupler to real-ear differences which were found to exist for gain are applied in selecting the desired $SSPL_{90}$ values as measured in the 2 cm[3] coupler (line 3). For example, it can be seen at 1000 Hz, that the functional gain exceeded the measured coupler gain by 8 dB. Therefore, 8 dB is subtracted from the desired real-ear SSPL to yield the desired coupler $SSPL_{90}$ of 107 dB. The final step in the selection process is to bring the frequency/$SSPL_{90}$ function in line with the desired coupler $SSPL_{90}$ values.

A word of caution is indicated regarding modifications performed in the fourth stage. As can be seen in Tables 1 and 2, functional gain is incorporated into the computation of the coupler defined modifications for both gain and SSPL. Our concern is that functional gain is determined by computing the difference between

Table 1. Example of how the functional gain to desired gain difference in dB (line 2) is applied to measured 2 cm³ coupler gain values (line 1) in computing the desired coupler gain (line 3) as a function of frequency.

	Frequency (Hz)				
	250	500	1000	2000	4000
Measured coupler gain	24	24	42	47	42
Functional gain/desired gain difference (dB)	1	4	11	10	5
Desired coupler gain	23	20	31	37	37

Table 2. Example of how the functional gain to coupler gain difference in dB (line 2) is applied to the desired real-ear SSPL values (line 1) in computing the desired coupler $SSPL_{90}$ as a function of frequency.

	Frequency (Hz)				
	250	500	1000	2000	4000
Desired real-ear SSPL	111	110	115	117	116
Functional gain/coupler gain difference (dB)	1	−4	8	3	8
Desired coupler $SSPL_{90}$	110	114	107	114	108

aided and unaided thresholds, both of which are conventionally measured in 5 dB increments. In view of this we would advise against any modifications, particularly an increase in the frequency/SSPL function, when a change of 5 dB or less is indicated.

SUMMARY

We have described a preliminary version of a speech spectrum based computer-assisted approach to selecting amplification characteristics for young hearing-impaired children. Before we can recommend clinical application of this procedure, however, a series of validation studies is clearly indicated. Nonetheless, our preliminary clinical trials suggest that, with this version, we have accomplished our goal of developing a systematic approach which is feasible within the structure of routine clinical practice. This approach has been specifically designed for young hearing-impaired children for whom reliable behavioural auditory threshold data can be obtained within more than one specific frequency region. Its application would be inappropriate for any individual with whom valid and reliable suprathreshold measurements are possible. For such individuals, more sophisticated and appropriate selection strategies currently exist.[2,8,9,11,32,33]

Finally, we would like to briefly comment on our selection of a computer assisted approach. We have not chosen to use a computer simply because it is in vogue to do so. The fact is that the current version of our selection procedure is not clinically feasible without the use of a microcomputer. During the early design stages we found that approximately 45 min were required to carry out all of the calculations included in the method. A computer assisted approach was selected because of its efficiency and accuracy. With the computer, all data entry, computation and printing of results as described in this paper require less than 3 min. The computer will not replace the role of the audiologist in selecting amplification characteristics for young hearing-impaired children; it merely facilitates the process. This aspect of the habilitation process will continue to require highly skilled clinicians who are able to perform precise measurements, who are creative and who are capable of using sound clinical judgment.

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