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Hello to you all! We have completed about 25% of our annual tour around the sun since we last met. As my grandma used to tell me when I said something I thought was profound, "Big events in the lives of little men." Well, this issue is a 3-part event.

It begins with our feature article on a company that's been around since the dawning of modern world of hearing health care and hearing aids. Beltone holds a special place among hearing aid manufacturers today; not just because of its hearing aids, nor because of simply how long they've been around. No, it's better than that. In the early days of "Hearing Aid Dealers" (don't you just hate that title?), Beltone was one of those forces that literally lifted us up from dragging our knuckles close to the ground. Anyone who reads about the history of our profession will find that there's a lot of dirt in our past. Hearing aids were sold door to door, out of the trunks of cars, and out of motel rooms. Many times, the dealers or sales people had scant training in the science of hearing, hearing testing, and the realities of coupling amplification devices to hearing impaired ears. The field of audiology emerged out of Northwestern University in the days of Raymond Carhart, and the two players – Audiologists and Hearing Aid Dealers – clashed head to head. The stale old stereotypes emerged about Audiologists being concerned about health while Hearing Aid Dealers were concerned about sales and making money. The rest is history. Beltone stepped right into the middle, and made it their business to train and upgrade the knowledge base of the non-audiologist, with seminars, manuals, props and guides. I remember my audiology professor (rest his soul), Loren Webb, PhD at Western Washington University, who always had a fondness and a soft spot for Beltone, and this is why. I am really glad to he told our class about this piece of history. In a health care field as young, but rapidly developing as ours, it is a good thing to recall and to hold close our history. I think you will find the article to be of interest. "Gotta like" the "retro" cover photo of their "new factory" in Chicago.

A past student of mine, Daniel Brinks has contributed the second article here, "Navigating Change." It's always heartening to watch how a fire is kindled inside (rather than under) a student – and now a new professional. Daniel posits his own observations of clinical reality today. In contrast to the Beltone article, Daniel looks from the present and into the near future. I think this is what most of us do today as it is. In his article Daniel points out three things to note: How we approach the bulging baby boomer generation that now has hit "senior citizen" status, the impact of advances in hearing aid technology, and required transparency on the part of the clinician regarding hearing aid prices and our services. Have a read.

I just had to weigh in with a pet peeve, as I love to rant about things that rankle. It took me forever to get some kind of a grasp on that devil that we have all encountered, called the "decibel." For years as an audiologist I simply shelved it all away and went on with my work. Out of sight, out of mind, right? Well, sometimes it's good to stand up and face one's foe. Guess what (I am whispering now), I will wager that among hearing health care professionals, I have a lot of company here. Many moons ago, when I began teaching at Auburn University in Alabama, I was forced to confront the decibel – because I had to ***teach*** it! There's nothing like teaching that makes one learn all over again. Later on when I worked at Unitron in Kitchener, I was forced to learn it once again, this time, from an engineering standpoint. Have you ever communicated with engineers? It's truly a "different" experience. Anyway, what you will read is an excerpt from a chapter I am presently writing for the 3rd edition of my little book, ***Compression for Clinicians***." Bear with me; it's only a rant. Here's from us at *CHR*; do enjoy your upcoming summer!

Ted Venema, PhD,
Editor-in-Chief

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1. http://arthritis.ca/manage-arthritis/ease-of-use-program/home-and-garden-products

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Well Hear We Are: The Beltone Story

By Steve Levenstein

About the Author

Steve Levenstein is a writer, editor and copyeditor based in his home town of Toronto, Ontario. Following his retirement after a long career in the food industry, Steve turned his hand to writing, regularly contributing automotive articles to The Driver *magazine and eventually assuming the role of the publication's editor.*

Steve has composed historical pieces for the Southern Arts Journal, penned a series of humourous rants & reflections for Burbia, and provided content for BizBash, Bitchin' Kitchen, and Odyssey Marine Exploration to name just a few. These days, Steve can be found online contributing illustrated, interesting and informative articles to WebUrbanist, WebEcoist, InventorSpot, and PetsLady.

"*From tiny acorns, mighty oak trees grow...*" This old aphorism describes the history of many of today's leading companies though, like naturally scattered acorns, only a few embryonic businesses manage to reach the highest heights. Beltone (a subsidiary of GN ReSound) is one of those success stories; a classic case of a good idea nurtured by enlightened management, progressive technical innovation, and a consistent focus on what their primary products mean to those who depend on them.

Beltone's primary products are hearing aids – accompanied by a robust service and support network managed through approximately 1,500 independently owned and operated hearing care centers. These centres provide screenings, fittings and follow-up care to Beltone hearing aid users for as long as they own their hearing aids. Beltone hearing products and services are available in over 50 countries around the globe. With headquarters in Glenview, Illinois and (since 1979) Toronto, Canada, Beltone has grown mightily over the past 75 years yet they have never strayed from their original mission of "*Helping The World Hear Better*".

SOUNDS OF WAR AND PEACE

Beltone's official slogan perfectly reflects the philosophy of the company's founder, the late Sam Posen. Back in the 1930s, the mechanically adept Posen crafted a rudimentary but effective hearing aid for a friend who was losing his hearing. Struck by the way a simple mechanical device could instantly change someone's quality of life, Posen knew he had found his calling: creating high-quality hearing aids en masse to suit the needs of individual customers! Of course, Posen couldn't launch such a grand enterprise on his own – he teamed up with his wife, Faye. Together they *were* the Beltone Electronics Corporation; the name was almost too big for the 120-square-foot office in downtown Chicago that housed the fledgling company. 1940 saw Posen working in the East Madison Street office's cramped back workroom turning out the Model H, Beltone's first-ever commercial hearing aid, one at a time while Faye (the smiling face of the company) greeted customers out front, tested their hearing and fitted them with hearing aids.

Figure 1. Beltone Model H.

Word soon spread of Beltone's quality products and personalized service. Within a year of the company's incorporation, a hearing aid distributor from Minneapolis convinced Sam and Faye to allow him to sell Beltone products in Minnesota. The distribution deal help boost business to the point where Beltone began offering 10-day free trials to dispensers in other cities and states. Things were really taking off for Beltone... unfortunately, other things were taking off as well: Japanese fighter planes with their bomb-sights set on Pearl Harbor. In the tense days following what FDR famously called a "*date which will live in infamy*," commonplace everyday items such as rubber bands, paper clips, and batteries were rationed as these materials were deemed critical to the war effort. Beltone was in quite a pickle: rubber, metal, and batteries were critical components of hearing aids. Sam Posen's vision of a world sounding clear as a bell was suddenly in jeopardy, dimmed by the fog of war.

While battles raged overseas, the home front saw its own share of struggles. Sam and Faye Posen found themselves in a particular quandary; business was booming yet parts shortages and an ever-increasing workload were holding the company back. In the spirit of the times, however, the pair were determined to triumph over adversity. One of the first steps they took was to expand Beltone's workforce. Sam looked no further than his immediate family to find Dave Barnow – Faye's brother – who became Beltone's first employee by assuming the role of sales manager. Drawing upon skills honed in the insurance industry, Barnow introduced the concept of an exclusive dispenser network that enabled Beltone to more closely control the flow of hearing aid products from factory to customer.

Dave Barnow's next move was to assure access to a new type of compact battery developed and produced exclusively for the U.S. Army Signal Corps. Once the manufacturer had set up their production line, the Corps was assured of as many batteries as they could use, and then some. Barnow was aware of the oversupply and worked doggedly to have Beltone granted a waiver from wartime restrictions. His persistence paid off: with the waiver safely tucked away in Barnow's vest pocket, Beltone was able to roll out a revolutionary new hearing aid: the Mono-Pac. Half the size and weight of other hearing aids, the all-in-one Mono-Pac was an instant hit, its popularity boosted by the company's first coast-to-coast advertising campaign.

Figure 2. Mono-Pac.

The runaway success of the Mono-Pac forced major changes at Beltone. With the war winding down, Beltone was gearing up: manufacturing operations were moved to a brand new 17,500-square-foot production plant staffed by 75 employees. Fifty distributors now marketed Beltone products nationwide. As Beltone was growing, the sizes of their signature products were shrinking. 1946 saw the introduction of the Beltone Harmony, a more compact successor to the Mono-Pac powered by a lightweight, efficient mercury battery. Meanwhile, Beltone International (as the company was now known) was diligently nurturing the service side of the business. Sam Posen designed the "Selectometer" so dispensers could refine the fitting process and enable comparative hearing aid testing on-site, at any site.

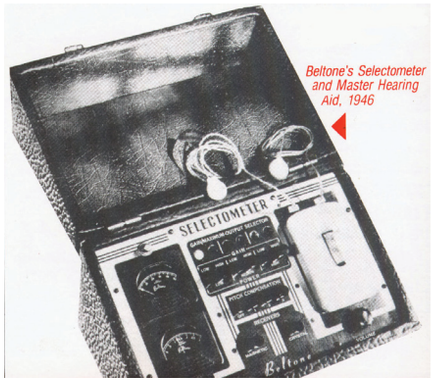


Figure 3. Selectometer Master Hearing Aid.

As Beltone's exciting first decade drew to a close, the company's founders, staff, and customers had much to look forward to. Amazing technological advances driven by desperation during World War II were about to fuel a renaissance in hearing aid design.

HAPPY DAYS

One notable advance was the advent of the printed circuit board. Commonplace in modern-day electronics, circuit boards were initially developed for bomb proximity fuses and it wasn't until the late 1940s that this "top secret" technology was released for civilian industry use. Beltone wasted no time in creating

the Symphonette, a hearing aid that featured a "Magic Silver Circuit" in the quaint parlance of the times. Charming prose aside, the Symphonette must have seemed genuinely magical as it was the first use of the printed circuit board by non-military industry in peacetime.

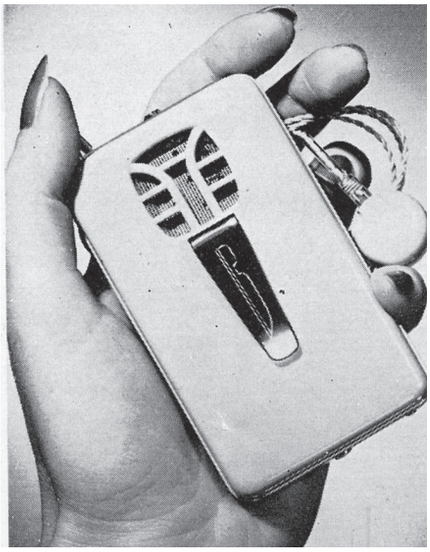


Figure 4. Symphonette.

The Beltone network had grown to over 100 distributors across North America as the Fabulous Fifties tantalized a society reveling in a post-war prosperity boom. Fittingly, Beltone's "silver circuit" hearing aids were being promoted – via a series of seven-minute commercial films – on shows broadcast over the air during the Golden Age of Television. Concurrently, the company invested in a national network radio ad campaign... *wait, what?* As unlikely as it sounds, a hearing aid manufacturer ran ads aimed at the hard-of-hearing on a medium that *could be heard but not seen!* Beltone's "think outside the box" philosophy ended up confounding the skeptics as leads from the mildly hearing-impaired as well as their friends and families poured into Beltone's Home Office.

Business was booming, driven by the one-two punch of technological innovation and customer service. In 1952, a mere six years after opening their first factory, Beltone International expanded into a custom-built 30,000-square-foot combination production plant / company headquarters on Chicago's 36th Street. New and improved hearing aid models hit the market in rapid succession:

Figure 5. Hearing test.

the Melody body-aid, the Lyric body-aid, the Concerto, the Allegro and the Operetta were introduced between 1950 and 1955. By the midpoint of the decade, Beltone hearing aids had moved from vacuum tubes to transistors in yet another paradigm technological shift.

From the start, Beltone had striven to make their hearing aids masterpieces of form as well as function. Thanks to miniaturization, the company's designers were able to explore progressive degrees of refinement in style without compromising their products' primary purpose. For example, Allegro and Operetta were designed to blend in with – and even complement – a fashionable woman's ensemble.

By the late 1950s, Beltone was making a habit of introducing great-looking, technologically advanced hearing aids. Take the "Hear-N-See", for instance: a binaural hearing aid seamlessly attached to a pair of spectacles. Pretty snazzy for 1956 yet less than a year later, Beltone doubled-down by rolling out an eyeglass-mounted hearing aid

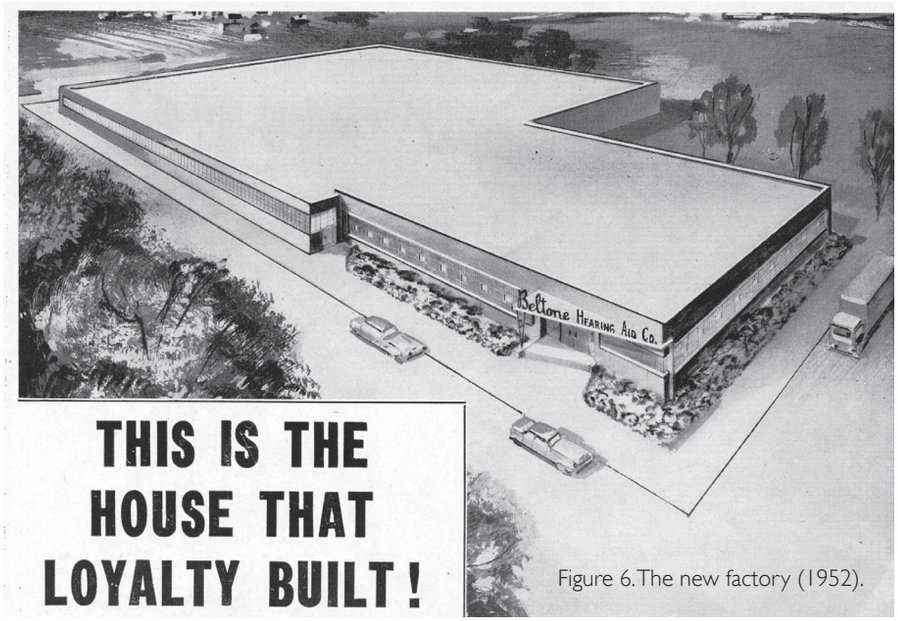


Figure 6. The new factory (1952).

that used bone conduction. Hot on the heels of those aural innovations came the Minuet, Beltone's first behind-the-ear hearing aid. It could be said that hearing aids completed the leap from being cumbersome, utilitarian medical instruments to stylish, life-enhancing conveniences when in 1958, an actress wore a Minuet hearing aid on a popular daytime TV soap opera.

LET'S DO LAUNCH!

At the dawn of the Space Age, Beltone's management were well within their rights to feel "*the sky's the limit*" yet Sam Posen's original vision still echoed from the halls of the executive suite down to the factory's production floor. Indeed, the 1960s would witness a renewed emphasis on hearing *aid* – help to the aurally-challenged that went beyond the fitting of mere mechanical devices. In 1961, Beltone took the unprecedented step of issuing a Philosophy Statement that laid out in no uncertain terms, the company's core dedication to assisting the world's hearing-impaired. The company then put their words into action by unveiling the Certified Hearing Service Plan, under which owners of Beltone hearing aids enjoyed FREE checkups throughout the lifetime of their device. It was a bold move, since by that time Beltone dispensers were operating in over 35 countries outside of the United States. The company and many of its distributors also donated thousands of dollars worth of surplus hearing aids and diagnostic equipment to the SS Hope, the famed hospital ship operated by Project HOPE between 1960 and 1974.

Figure 8. HA fitting with eyeglass HA.

Just as the Second World War had spurred a wide range of civilian commercial spin-offs, the Cold War and the Space Race of the 1960s had a similar effect. The name "TANG" may ring a bell but so might the Utopian, Beltone's first in-the-ear hearing aid, or the Serenade, a groundbreaking behind-the-ear hearing aid that featured a nearly invisible electronic circuit fused into a tiny waver of pyrex glass. The so-called "Micro-Module" circuit in the heart of the Serenade was invented by Larry Posen, Sam and Faye's son, who had begun applying his hard-earned college engineering degree on Beltone's behalf. Larry joined 450 other Beltone employees at a new 80,000-square-foot plant – the company's fourth major expansion.

By the end of the tumultuous decade of the Sixties, mankind had lifted their eyes to the moon and stars... and Beltone was along for the ride! Concerned by potentially damaging noise levels experienced by Apollo astronauts during lift-off and re-entry, NASA contracted with a Beltone distributor in Texas to craft custom earmolds for every active astronaut. The result: *Houston, we have no problems!* Back on terra firma, Beltone responded to a request from legendary NFL coach Vince Lombardi for a unique, in-helmet hearing aid that helped Washington Redskins running back Larry Brown hear plays called on the football field.

GAINS, LOSSES, AND NORTHERN EXPOSURE

The 1970s opened with a bang at Beltone as work began on a 50,000-square-foot extension to their production facility. Actually, you could have heard a pin drop... once the addition's state-of-the-art anechoic chamber was completed. Boasting

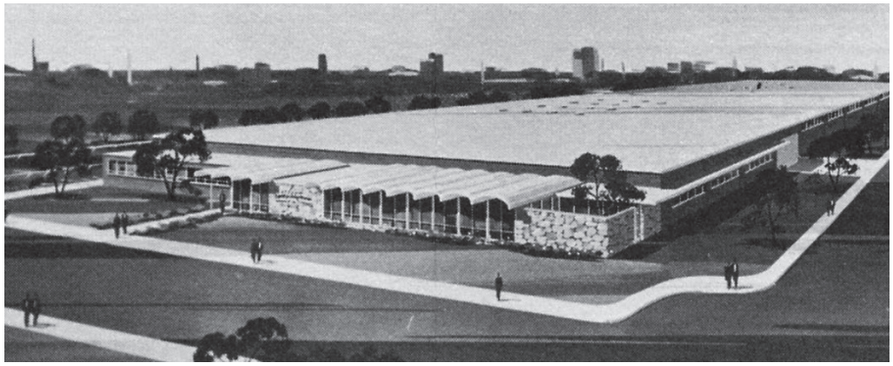


Figure 9. New factory (1963).

17-foot-high ceilings and insulated walls and floors that rendered it virtually soundproof, the chamber was designed to facilitate research into the more esoteric problems of hearing loss.

The first fruit of Beltone's renewed push for higher-tech solutions for the hearing impaired came in 1977 when the Solo in-the-ear hearing aid was introduced. The Solo featured a Beltone-developed integrated circuit – a mechanical innovation that heralded a new generation of smaller, more powerful hearing aids. Though the Space Age was coming to an end, the Computer Age was just beginning and, as always, Beltone was at the cutting edge.

1979 was a pivotal year in Beltone history as Beltone Electronics of Canada, Ltd. opened its doors to better supply and service customers in "The Great White North." Though American-made behind-the-ear, eyeglass and body-worn aids were still imported to Canada, Beltone's newer in-the-ear and (from 1983) in-the-canal hearing aids were now being manufactured at the new state of the art Ontario production plant. Canadian customers could now enjoy the same quick turnaround time as their fellow Beltone users south of the border. Repeating what had become a company trend, Beltone Electronics of Canada soon outgrew its initial facilities and, in 1987, moved to a larger 10,000-square-foot factory and headquarters building on Supertest Rd in northern Toronto.

Just as Beltone's Canadian operations were finding their rhythm, however, the company was rocked by tragedy: Sam Posen, Beltone's founder and chairman of the board, had succumbed to ALS (amyotrophic lateral sclerosis, known colloquially as Lou Gehrig's Disease) at the relatively young age of 71. Larry Posen, Sam's son and Beltone's president since 1974, stepped into his father's shoes and though the company's guiding light had dimmed, its founder's vision remained to illuminate the way forward into a new and exciting era.

The 1980s were a momentous decade for Beltone and the hearing aid industry as a whole. In 1983, President Ronald Reagan was fitted with his first hearing aid (Ed note: by Starkey). First Lady Nancy Reagan was quoted as stating "*Now when I whisper sweet nothings in his ear, at least I know he'll be able to hear me.*" (Psst, Ronnie... Just Say No!)

By this time, Beltone had grown to become a recognized industry leader known for always looking ahead; never resting upon their laurels. The same year President Reagan began wearing his hearing aid, the company rolled out their model ODE – the world's first custom in-the-ear-canal hearing aid. Tough act to follow? Not for Beltone: in 1985 and after ten years of development, refinement and experimental trials, the FDA approved the Nuclear 22 Channel Cochlear Implant system for adult patients suffering from profound hearing impairment.

FAST FORWARD TO THE FUTURE

The last decade of the twentieth century saw widespread integration of two crucial technological trends: advanced miniaturization and increased computing power. While consumers benefited through the sale of smaller and more powerful telecommunication devices, Beltone took advantage of these prevailing tech trends by applying them to a new range of hearing aids. A prime example is ANF (Automatic Noise Filter), a feature designed to reduce background noise while improving speech intelligibility. Advanced microprocessors would make their debut in the Model 2000, Beltone's most advanced testing audiometer. Changes were afoot in the corporate corridors as well. In 1997, Larry Posen retired from Beltone and in the year 2000 the company was purchased by GN ReSound.

In March of 1992, Frank Skubski began his long career at Beltone Canada as a sales representative; rising to the position of sales manager in 1998. Wearing two hats as the Canadian operation's general manager (since 2007) and site manager, Skubski leads all commercial activities for Beltone Canada including sales, marketing, customer service, and product management. "*As Site Manager,*" explains Skubski, "*I oversee Toronto operations ensuring a safe and productive environment while ensuring our Quality Management System is adhered to.*" Since January of 2015, Skubski has been president of the Canadian Association of Hearing Instrument Manufacturers, a reflection of both his and Beltone's esteemed reputations amongst industry peers.

A new millennium (remember "Y2K"?) had arrived and it business as usual at Beltone, now an independent brand under the corporate umbrella of GN Store Nord A/S, a Denmark-based manufacturer of hearing instruments, audiological diagnostics equipment, and headsets. GN ReSound took a hands-off approach to managing their overseas acquisition, being well aware of Beltone's impressive 60-year track record – "*why fix it if it ain't broke,*" one might say (in Danish). Led by company

president Todd Murray, Beltone's North American operations kept calm and carried on, taking full advantage of the astonishing advances in the telecommunications industry and applying them to a series of cutting-edge hearing aids such as the Beltone Marq (2004) and Beltone True (2010) receiver-in-ear hearing aids. The digital revolution, convergent technologies and the burgeoning connectivity of 21st century society led to the development of wireless hearing aids designed to work with mobile phones, specifically the immensely popular Apple iPhone. Beginning in 2013, iPhone- and Apple Watch compatible hearing aids including the Beltone First, Beltone Boost, Beltone Legend, and Beltone Ally progressively enabled hearing aid users to control and customize their devices via dedicated apps.

Much like telephones, hearing aids have come a long, long way since 1940 yet some Beltone customers have been around long enough to experience that incremental march of progress in person. Beltone founder Sam Posen wasn't one of those lucky enough to witness the entirety of his company's journey but he probably wouldn't be surprised by today's Beltone. His original dream – helping the world hear better through the application of technology via a network of hearing healthcare professionals – continues to be realized day by day, customer after customer.

Figure 10. Hearing aid history.

Navigating Change

By Daniel Brinks HIS, Hear Right Canada, Hamilton, ON

About the Author

Daniel Brinks is a hearing instrument specialist (HIS) and a graduate of the HIS program at Conestoga College, in Kitchener Ontario. There he learned under many great teachers, including CHR's *editor, Ted Venema. He has been a clinician at ActivEars Hearing Clinic in Sarnia, ON and is currently in transition to a new position at Hear Right in Hamilton. He owes his career to two great women; his wife for getting him through school, and his mom for the background and inspiration.*

A few months ago I assisted a 100-year-old lady in replacing her broken hearing aid. It was almost identical to her old one, but not quite, and one slight difference where it exactly sat behind her ear proved to be the biggest challenge in her satisfaction!

Change is difficult, and not only for a client with a new hearing aid, but also for a clinician. Our industry is continually in a state of advancement, yet we often find ourselves remaining resistant. In the fall 2015 issue of *The Hearing Professional*, Kathleen Mennillo MBA, executive director of IHS, wrote about change and innovation. She gives a beneficial first step to consider; "And even though change can be unnerving at times, it is always good to challenge our way of thinking. This is when innovation is born. And from innovation comes opportunity."1 While Mennillo may be approaching innovation in regards to technology, I believe innovation can be applicable to client care also; our role contains both aspects. The purpose of this article is to identify three main waves of change in regards to client care, and assist in navigating a response to each one. These waves of change consist of (1) shifting patient demographics, (2) accelerating advancements in non-hearing aid technology, and (3) increasing advocacy for people with hearing loss. In other words, these areas of client care consist in changing our approach with "baby boomers," learning about and considering non-hearing aid hearing technology, and advocating for those who are hard of hearing by being transparent about services, prices, and hearing aid component costs.

THE BABY-BOOMER AGE GROUP (BORN BETWEEN 1946 AND 1964 HAVE MORE EXPERIENCE AND KNOWLEDGE REGARDING THE TECHNOLOGY OF TODAY'S HEARING AIDS THAN DID THE GENERATION BEFORE THEM.

First of all, in order to navigate the change of demographics with younger clients, we need to look at how we approach them. The baby-boomer age group was born between 1946 and 1964, making them 52 to 70 years of age now. They have more experience and knowledge regarding the technology of today's hearing aids than did the older generation before them. Over the past several years, our task has morphed into one that is required to answer the many questions they have about technology, whether it has to do with cell phones or the squealing hearing aids from the man in church. We need to address the negative experiences they have heard about from their Great Aunt Ruth or their friends who wore much simpler analog hearing aids. Amidst all of their questions, they need to still trust us with their money and feel supported in their journey of better hearing.

In order to accommodate and address a baby-boomer's concerns, a new approach is necessary. I have seen a couple different approaches to hearing health care thus far. One is Dr. / Patient relationship. "I recommend this one hearing aid. Please sign here." The implication is "I know best, you don't need to know much at all about this…and I am busy, so let's get going already." Another is a salesperson approach. "You will be able to hear your TV, your radio, talk on the phone, AND still hear the crickets – all at once!" The implication is technology has surpassed how our ears were designed, and hearing aids can do anything; this can only lead to high, unrealistic expectations. Obviously I have mentioned extremes here, and there needs to be a balance with elements of each in our interactions.

Yet, as our baby boomers increase, any tendency to lean toward these two extremes will need to decrease, in order to accommodate their previous knowledge and experience. Christina Young writes the following thoughts in her article, "Baby-Boomers, Taking a Different Approach."

"It's no surprise that baby boomers approach us with caution, and sometimes outright hostility. Everyone who knows a "grandma" has personal proof that "hearing aids don't work." It's only logical that they would resist hearing aids for themselves. Instead of feeling threatened by these complaints, this is a teachable moment. This means the baby boomer has some understanding of hearing aids, as well as limits of their functioning. If we congratulate them for having practical experience, we show the baby boomer customer that we believe them, and that we are listening. This may seem a strange thing for a licensed specialist to believe, but this is the essential shift that we must demonstrate in our initial consultations with our baby boomer clients."[2]

Young goes on to say we can utilize their questions by *taking time to explain and educate* on hearing, and what role hearing aids play in hearing health care.[2] There are a couple key words mentioned above, revealing useful implications; "listening," which promotes trust between the clinician and the patient; and "congratulate," which pats the patient on the back, showing they have critically thought about the issues surrounding their hearing and hearing loss. These are useful words because they suggest sincere rapport-building tools, and get to the core of why the patient is there in the first place.

In my opinion, the goal is to identify the baby boomers as a major wave of change, and accordingly recommend products, including education and patient involvement in decision-making. *We live in an information (overload) age, yet there is little known about our invisible disability in the general public*. Hair cells are not as known as retinas, but they should be, and the difference between sensori-neural hearing loss and diminished eyesight should be highlighted to our clients over and over again. For example, the vast majority of eyesight problems are "conductive" in nature. A simple re-focus places incoming light precisely upon an intact retina. Not so with hearing loss; the vast majority of hearing loss is sensori-neural, which is akin to having damage to the retinas per se. Glasses, like hearing aids then, become only a partial solution. This is the boat in which we sit. It's why counselling is such a huge part of our field. The daily work of the optometrist/optician versus the audiologist/hearing aid practitioner is dictated by the vastly different nature of damage to the end-organ (eye versus ear).

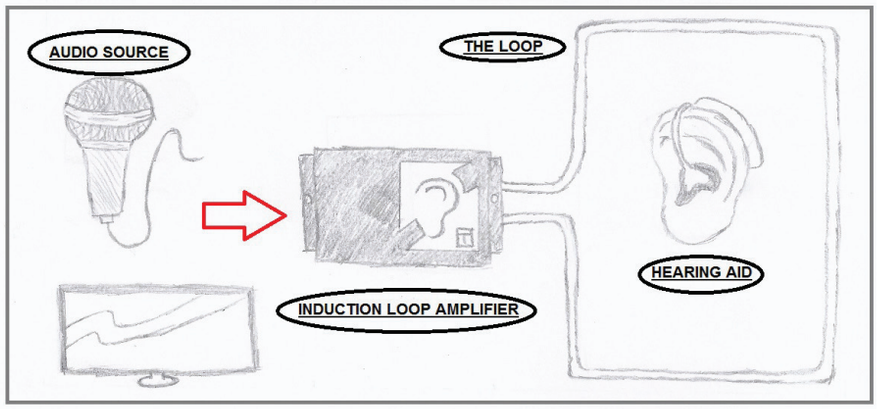
To appreciate the differences being discussed here, just walk into any optical outlet. Witness the difference in tone, feelings and general surroundings. The whole experience is different, more lighthearted, and easier to understand. The public just "gets it." They have come in to buy glasses, and it's just a matter of deciding on the frames that look best. Hearing aids are not as common as eyeglasses, and they are not nearly as well understood. Most people think they just make sounds louder, as if all hearing losses were flat and conductive in nature! No, we don't need to teach our clients about hearing aid compression, but we could explain that part of the reason for their higher cost is that they constantly have to change the amount by which they amplify (soft sounds by a lot, and loud sounds by less). Most of the time clients will have read reviews on companies, products, and prices online. We must listen to what the client already knows, and add a more complete framework of knowledge, experience and expertise. The client then feels involved in this process, for we have met in the middle, and together decide on the next course of action. Innovation is born!

In light of the baby boomer's online presence and awareness of technology, we must notice the second wave of change; advancements in *non-hearing aid* technology. The cost of new technology is a main motivation for folks to look elsewhere beyond hearing aids. Many people with mild/moderate high frequency hearing loss are asking the following question: Is spending three to five thousand dollars the only answer for me to have my needs met in my present situation? I would encourage everyone to seriously read and think about Brian Taylor's article about "Creative Deconstruction" in IHS.'s latest issue of *Hearing Professional*.[3] Taylor talks about how adaptation is needed to "effectively meet the changing demands of the marketplace." Unless we bury our

IN LIGHT OF THE BABY BOOMER'S ONLINE PRESENCE AND AWARENESS OF TECHNOLOGY, WE MUST NOTICE THE SECOND WAVE OF CHANGE; ADVANCEMENTS IN *NON-HEARING AID* TECHNOLOGY.

heads in the sand to avoid change, we need to reflect on how mobile and innovative technology is changing the hearing aid landscape. After wading through the apps, speakers, and other lower-cost and alternative ways to "aid-hearing," Taylor comes to an interesting conclusion to consider, which may help navigate the future of hearing health care.[3]

"One way to prepare for a different future, one that is likely to be creatively disrupted by cheaper, faster and smarter technology is to examine existing gaps in the marketplace and how our professions can add additional value that may not be centered on the selection, adjustment and tweaking of hearing aids, or the ability to conduct a basic hearing assessment."[3]



THERE HAS BEEN A RECENT RESURGENCE IN LOOP SYSTEMS, INTENDED TO INCREASE THE SIGNAL-TO-NOISE RATIO BY MEANS OF WORKING WITH THE TELECOIL IN HEARING AIDS.

This challenges our thinking, for it reaches beyond the core elements of our industry. Is this something our industry is ready to consider? How about those Personal Sounds Amplifiers (PSAPs)? They are relatively low-cost, over-the-counter hearing devices that are meant to amplify sounds for those with mild-moderate hearing loss. While not being actual hearing aids, they might be of benefit for those who are not quite ready or do not have financial assistance to purchase hearing aids. Then again, there is the recent resurgence in loop systems, intended to increase the signal-to-noise ratio by means of working with the telecoil in hearing aids.

The third and final wave of change relates to advocacy for those who are hard of hearing, by being *transparent about prices and services*. We must bridge the gap between the technology and the person who many times knows very little about how to proceed and succeed in the journey ahead. This is where empathy comes in. I have had patients reveal their confusion about what to do with all the ads in the paper, not knowing what price is fair. We can look at ourselves as being experts in being able to educate and bridge the gap between the general public and the mysterious hearing aid industry. Many folks have seen the CBC documentary on the 'actual cost' of hearing aids aired a few years ago, and this cynical position may be all they know. We can always make the analogy that our laptop computers too may not be worth more than some $65…but just try making one yourself!

The recent issue of *CHHA.'s Listen/Ecoute* magazine has in-depth articles tackling the topic of hearing aid cost. Again, the nature of damage to the end organ in question (sensori-neural hearing loss with the ear versus conductive vision loss for the eye) factors in here in a huge way. Not only does compression enter the picture here, but also directional microphones (Dmics) and digital noise reduction (DNR). Hearing aids should always be explained in that they have a two-fold task. They not only have to amplify, but they must also increase speech compared to competing background noise. Compression is a gain feature, while Dmics and DNR are signal-to-noise features.

A question and answer article from electrical engineer, Steve Armstrong, B. Eng., electrical engineer, highlights important elements for a clinician to consider. Manufacturing DSP chips and research and development are two core costs related to the actual hearing aid itself.[4] Our professional fees are

also a significant part of hearing aid costs. Many people know hearing aids cost thousands, but do not understand the breakdown of costs associated with the product, including our invaluable and often unlimited service. Our clients are not only buying a machine, but are also receiving hearing health care for approximately five years. Our services are not limited to testing, recommending, and fitting, but must also contain transparency to everyone. Unveiling the realities of the costs may in turn assist patients to plan ahead, expect solid service, and appreciate the quality found in a highly manufactured device.

In conclusion, a clinician must shift approaches and be responsive to the unique needs of 'baby-boomers.' Innovation and opportunity will be born from our ability to see the potential in non-hearing aid technology. Lastly, a clinician who is transparent about prices and services, will break down barriers of misinformation and guide clients along their journey toward better hearing.

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MANY PEOPLE KNOW HEARING AIDS COST THOUSANDS, BUT DO NOT UNDERSTAND THE BREAKDOWN OF COSTS ASSOCIATED WITH THE PRODUCT, INCLUDING OUR INVALUABLE AND OFTEN UNLIMITED SERVICE.

THE DECIBEL FROM HELL

By Ted Venema, PhD

About the Author

Ted Venema taught at Conestoga College in Kitchener, Ontario and was the founder of its hearing instrument specialists (HIS) program. He has a PhD in audiology from the University of Oklahoma. Ted is presently teaching with the online distance ed HIS program at Ozarks Technical Community College in Springfield Missouri. He frequently gives presentations on hearing, hearing loss and hearing aids, and he is presently writing the 3rd edition of the textbook Compression for Clinicians.

It is hoped that the title here does not scare off any potential readers. The following is simply a monologue discussion on an animal we as hearing health care providers encounter on a daily basis; the decibel. We have learned and are often vaguely aware that we cannot really add decibels the way we normally add things together, and yet we do it all the time when fitting hearing aids. The purpose of this article is merely to address some things about the decibel, especially as these relate to our daily task of fitting hearing aids.

INPUT + GAIN = OUTPUT

The most important formula for understanding hearing aids and their function is: Input + Gain = Output. *Input* is the sound arriving at the microphone of the hearing aid, *gain* is the added amplification to the input, and *output* is the sum total arriving at the TM. Input and output are always measured in units of dB sound pressure level (SPL), while gain is always measured in units of dB. Why is this the case? Then again, we all remember hazy shades of past agonies trying to absorb the decibel, one of these being the fact that "You cannot add decibels like 1 + 2 = 3!" Wait a minute; we just did. Input + Gain = Output.

To find our way home, we must look at or define "absolute" versus "relative" decibel values. First, what do we mean when we say "0 dB SPL? Contrary to what one might think, this does not represent the absence of sound. Ever test oto-acoustic emissions? Check out the decibel values there. The noise floor in the ear canal is often –10, –20 dB SPL. It thus behooves of us to get a sane grip on the decibel (from hell).

0 dB SPL simply represents the softest sound pressure for a normal-hearing person to hear a (1) 1000 Hz tone, (2) at a one-meter distance from a speaker, (3) with both ears. All greater (and lesser) sound pressure levels are related to this all-important, defining "ground level." If we want to say an apartment building is twice as high as the house next to it, we need to know where the ground is, because that is the starting point for both buildings. All decibel values that are related to 0 dB SPL are "absolute" values. Inputs and outputs are absolute values, as they are related in intensity to their common ground of 0 dB SPL.

If you play this same listening "game" with other frequencies, you will note that it takes more pressure than that represented by 0 dB SPL to just barely hear frequencies lower than 1000 Hz, then between 2000 – 4000 Hz, it takes less pressure, and then above 4000 Hz more pressure is once again required. Figure 1 shows that our thresholds across the frequencies then look a big smile, also known as "minimal audible field (MAF)." The big MAF curve results largely from the contributions of our outer and middle ear resonances. Now if we play the same game yet again but this time, with a headphone over one ear alone, we get another big curve called "minimal audible pressure (MAP)." This "smile looks a bit different from MAF.

First, it is slightly elevated, showing that in essence, two ears are some 5 dB better than one. This difference "differs" across the frequencies as well. Look at what happened to MAP between 2000 and 4000 Hz! There's a bulge there, and it results from the fact that now you've plugged up one ear with the headphone, thus obliterating the contribution of its natural resonance. That's why the MAP curve at the bottom of real ear measurement (REM) screens looks the way it does; it too has that little bump between 2000 and 4000 Hz. By the way, the MAP for any particular headphone in question would represent 0 dB HL on an audiogram.

Regarding absolute decibel values, they are all based on logarithms (base 10). This is because for the normal-hearing person, the range of intensity from just barely audible to the threshold of feeling or pain is very large. The largest sound pressure one can generally tolerate (120 dB SPL) has a million times the pressure of 0 dB SPL. We do not want to deal with millions when dealing with audiometry; we would much rather deal with an audiometric range of 0 to 120 dB. In terms of sound pressure then, 20 dB SPL has 10 times the pressure of 0 dB SPL, 40 dB SPL has 100 times the pressure of 0 dB SPL, and so on until we get to 120 dB SPL, which has 1,000,000 the pressure of 0 dB SPL.

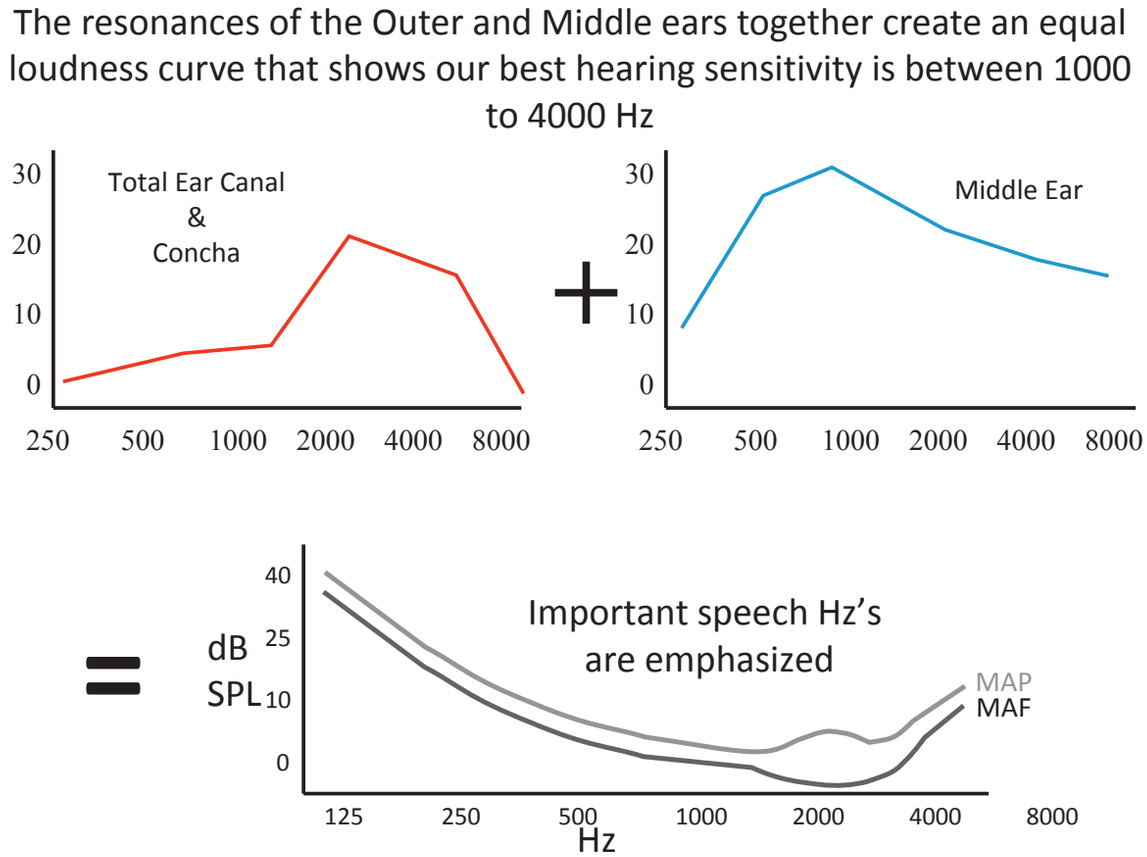

Figure 1. The resonance of the pinna and outer ear canal are shown in the top left panel, and the resonances of the middle ear are shown in the top right panel. The combined contributions of these resonances result in the equal loudness curves, shown in the bottom panel. The bottom curve is a rough depiction of MAF; namely the softest intensities required for normal-hearing humans to just barely hear all the various frequencies. Note that 1000 Hz corresponds to 0 dB SPL. The top curve shows a rough depiction of MAP; namely, the softest intensities required for normal-hearing humans to just barely hear all the various frequencies with one ear under a headphone. Note that the drop in MAF above 2000 Hz reveals the resonances of the open ear concha and canal. The bump in MAP at roughly similar frequencies represents what happens when this resonance is lost by plugging up the outer ear canal with a headphone.

Because the decibel is based on logarithms, two ***absolute*** dB SPL values that are referenced to 0 dB SPL cannot simply be added together like 1 + 2 = 3. Consider for example, a 1000 Hz tone at an intensity of 20 dB SPL. If we double its sound pressure, the sum total is now 26 dB SPL. If we increase its pressure by a factor of 10, then we are now at 40 dB SPL. The "fun" increases further still when we consider adding two tones that are of equal intensity but different in frequency. A 1000 Hz tone at 20 dB SPL plus a 1500 Hz tone at 20 dB SPL equals a sum total of 23 dB SPL. Two ***identical*** machines each producing 85 dB SPL of noise, when combined together would total 91 dB SPL. This is not usually the case in the real world however, when combining intensities. Two ***different*** machines, each producing 85 dB SPL of noise, when combined together the total is thus only 88 dB SPL!

Then again, in the real world we are not always adding together two equal decibel values. Due to the fact that the decibel is based on logarithms, a 60 dB SPL sound has lots more pressure than a 50 dB SPL sound. Adding these two together basically produces a sum total that is slightly (but not much more than) 60 dB SPL. Here, 60 + 50 = basically 60. By analogy, an elephant plus a mouse is basically an elephant.

Gain is completely different. As opposed to input and output which are absolute decibel values, gain is a "relative" decibel value. One can add 50 dB gain to a 10 dB SPL input to get a 60 dB output. Then again, one can add 50 dB of gain to a 50 dB SPL input to get a 100 dB SPL output. The gain here is relative. That is why gain is stipulated in terms of simple "dB." Along with gain then, here comes the good news. One can add a relative decibel value to an absolute decibel value like simple arithmetic; such as: 1 + 2 = 3.

Back to our examples of machines, a combined total of two identical machine, each making 85 dB SPL of noise, results in a gain of 6 dB (85 dB SPL + 6 dB gain = 91 dB SPL). A combined total of two different machines, each making 85 dB SPL of noise, provides a gain of 3 dB (85 dB SPL + 3 dB gain = 88 dB SPL).
Those who measure dB SPL in worksite environments for the potential in for assessing the risk of noise induced hearing loss must deal with the strict addition of absolute dB SPL values. In our world of hearing aids, where gain is added to inputs to create outputs, we can be glad of the simpler way to add decibels. With hearing aids too, the gain is almost always more than 6 or 3 dB. For example, 10 dB SPL input plus 50 dB of gain equals an output of 60 dB SPL. So also, 50 dB SPL input plus 50 dB of gain totals 100 dB SPL of output. One can readily see here that the gain of 50 dB is a relative value; it can be added to any input having any dB SPL.

There are other situations where we refer to dB and not dB SPL. For example, when trying to hear speech (the signal), with hearing aids, the biggest curse is background noise. To that end, we try to improve the signal-to-noise (SNR) ratio with directional microphones, etc. Well, SNR is also a relative dB value. Noise can be 50 dB SPL and the speech signal of interest might be 55 dB SPL. Then again, noise might be 80 dB SPL and the speech signal of interest might be 85 dB SPL. In both instances, the SNR is 5 dB.
So also, dynamic range is expressed in units of dB versus dB SPL. Let's say someone has a hearing threshold of 0 dB HL for 1000 Hz, and a loudness tolerance level for the same frequency at 100 dB HL. The dynamic range here is the ***difference*** or "decibel distance" between the threshold or "floor" of hearing sensitivity and the "ceiling" of loudness tolerance; namely, 100 dB. Compare this to another person whose threshold for 1000 Hz is 50 dB HL and loudness tolerance for the same frequency is 100 dB HL. Here, the difference or decibel distance between the "floor" and "ceiling" is smaller, giving a dynamic range of only 50 dB.

Another example is seen In today's REM, where we commonly use what is known as "real ear-to-coupler difference (RECD)." ANSI testing employs the use of a closed 2cc coupler when measuring the output from a hearing aid. This is done in order to "imitate" the volume of air trapped between the end of a hearing aid in an ear canal and the eardrum. The closed ear canal, however, is actually smaller, about 1 to 1.5 cc in volume. The RECD then is simply the difference in the frequency response of a hearing aid while measured in a 2 cc coupler versus being measured in a real ear canal (Figure 2). The difference here again, is always expressed in simple dB.

GAIN VERSUS OUTPUT IN REM

Gain is always described in units of dB, while output is always described in units of dB SPL. Today's REM commonly displays the results of compression in hearing aids, along with the targets of today's compression-based fitting methods. As we all know, compression provides different gain for different input intensity levels. As a result, the frequency responses of a compression hearing aid will change accordingly. In ***frequency responses***, however, changes in hearing aid gain will look

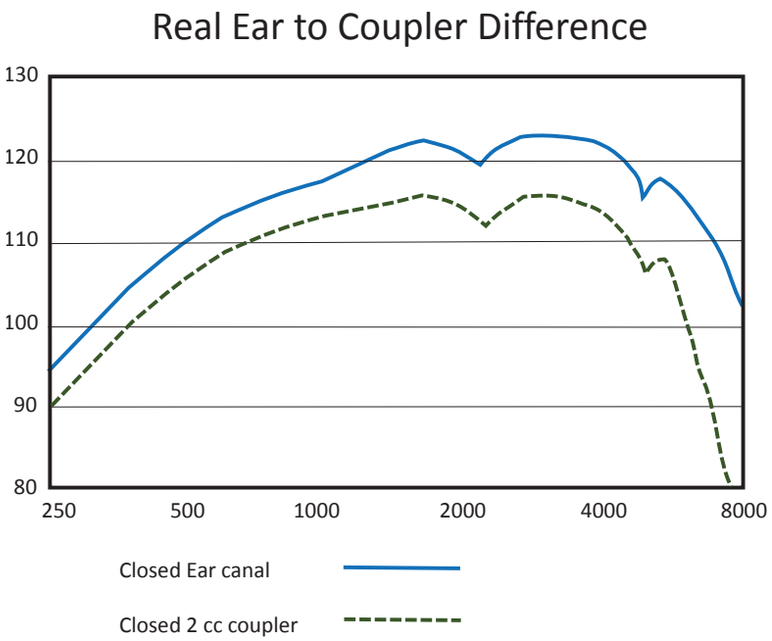

Figure 2. A maximum power output is shown as a frequency response of hypothetical hearing aid in a 2 cc coupler and in a typical adult real ear canal. Note that the real ear-to-coupler difference is about 5 dB below 1000 Hz and about 10 dB above 1000 Hz. The larger 2 cc coupler thus underestimates what the hearing aid will do in the real ear canal.

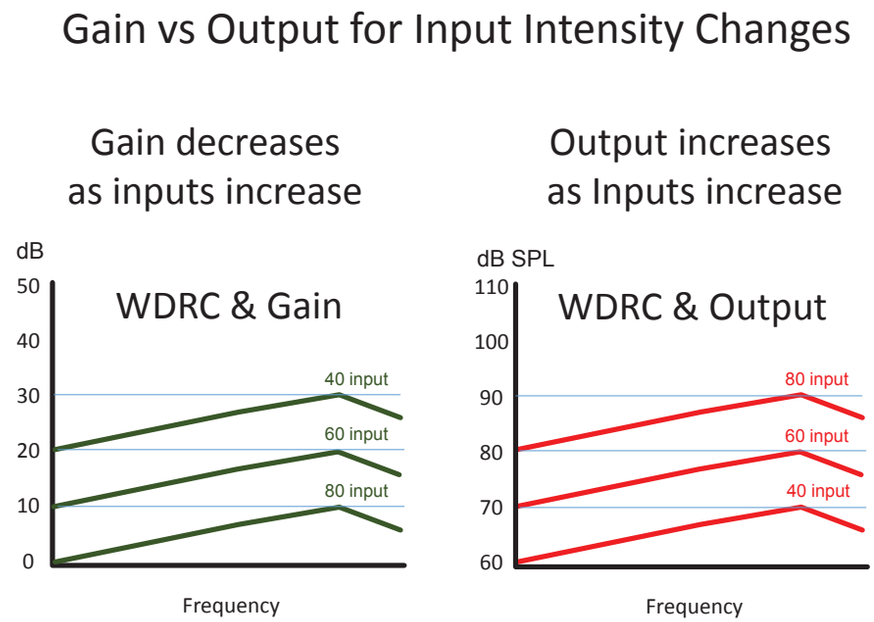

Figure 3. Both panels can be seen as either the frequency responses for a WDRC hearing aid, or the fitting method targets for a hearing loss with the same WDRC hearing aid. The left panel shows the decreases in gain with increases to input levels. The right panel shows the corresponding output increases that occur with increases to the same input levels. Note that the trends for gain and output go in opposite directions.

very different from changes in hearing aid output. Similarly, fitting method targets for any particular hearing loss also change with changes to input levels. Again, targets plotted in terms of gain will change very differently from targets plotted in terms of output.

Figure 3 shows an example of how changes to input intensity levels with wide dynamic range compression (WDRC) can have a markedly different effect on gain as compared to output. Both panels of Figure 3 can be seen as either the frequency responses of the WDRC hearing aid, or else as the fitting method targets for a particular hearing loss with the same hearing aid. The frequency response (or targets) are displayed in terms of both gain (left panel) and output (right panel). As we know, the purpose of WDRC is to imitate the unique amplification role of the outer hair cells. As an amplifier, the cochlea thus provides most gain for soft inputs, and progressively less and less gain as the inputs become more intense. The same is true for WDRC.

In Figure 3 (left panel), it can be seen that for WDRC, the gain is greatest for soft inputs of 40 dB SPL and least for more intense inputs of 80 dB SPL. If construed as target gain for the various input levels, once again, greatest gain is asked for the softer input levels. By the way, this is also how one of the first compression-based fitting methods (NAL-NL1) used to display its targets for the new WDRC hearing aids that began to emerge in the late 1980s and early 1990s. The DSL fitting method really led the way in plotting its targets in terms of output, rather than gain. Today, all of our compression-based fitting methods do this. For DSL then, imitation is the finest form of flattery.

The right panel of Figure 3 shows the behaviour of the very same WDRC hearing aid in terms of *output*. In contrast to gain shown in the left panel, the top output function is that for the louder input of 80 dB SPL, while the bottom output function is that for the soft input of 40 dB SPL. The output functions are thus laid out in the opposite direction (top to bottom) from the gain functions in the left panel.

In order to better *internalize* the differences between displaying frequency responses plotted in terms of gain versus output, the reader is referred to Figure 4. Another example of a WDRC hearing aid is displayed in terms of its gain versus its output behavior. As with Figure 3, both panels can be seen as either the frequency responses of the WDRC hearing aid, or else as the fitting method targets for a particular hearing loss with the same hearing aid. The vertical axes in both figures have the same 10 dB increments. In Figure 3 the three different input intensities result in similar 10 dB gain and output changes across all frequencies. In Figure 4 the gain (left panel) for all three inputs is similar for the low frequencies, while the gain for the three input levels is different for the high frequencies. This situation is actually quite common, as most clients with SNHL have good hearing for the low frequencies, and thus they require very little amplification for the low frequencies.

The corresponding *outputs* in Figure 4 are a bit tricky to understand because they look very different from the gain changes shown in the left panel. They also look very different from those in the right panel of Figure 3. The output changes show an interesting trend that is not seen in Figure 3. The small low-frequency gain changes (left panel) result in rather large low-frequency output changes (right panel). Then again, the larger 10 dB high-frequency gain changes that are shown beneath the intensity levels in the figure, result in exactly the same degree of output changes for the high frequencies. When trying to discern and break down the logic here, the reader is encouraged to do two things: first, always remember that input + gain = output. Second, look at the axes carefully, and let the graphs tell their stories.

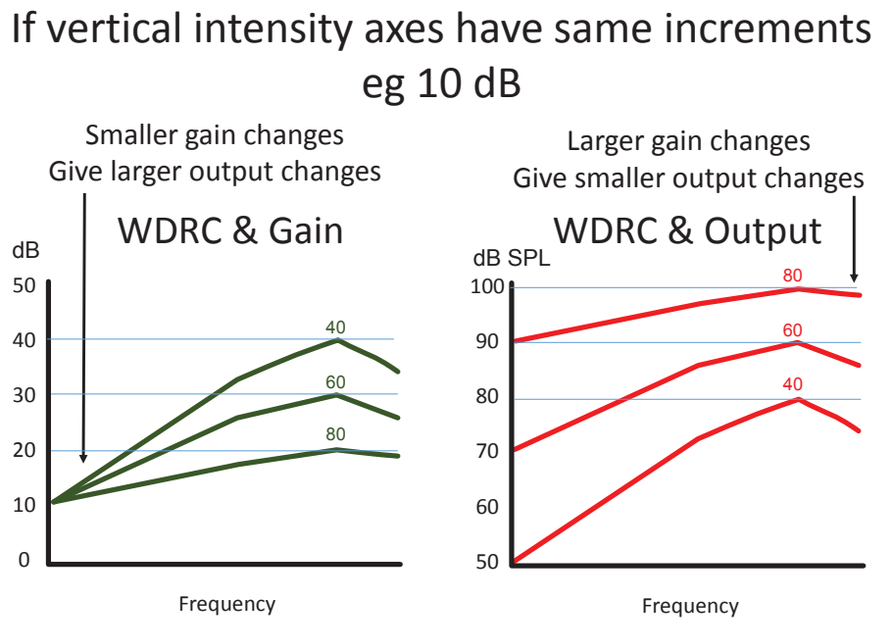

Figure 4. As with Figure 3, both panels can be seen as either the frequency responses for a WDRC hearing aid, or the fitting method targets for a hearing loss with the same WDRC hearing aid. In this example however, changes to input levels result in similar gain (left panel) for all inputs at the low frequencies. The maximum gain changes occur at the high frequencies. Note that corresponding outputs (right panel) show the largest differences precisely where the gain (left panel) shows the least differences. The smallest output differences are seen precisely where the gain shows the largest differences.

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