

Why Some Hearing Aids Don't Work Well!!

Adequate dispenser counseling and top-quality impressions are essentials to the fitting of wideband hearing aids, particularly the WDCRC-TILL variety.

By Mead C. Killion, Ph.D.

There are four factors that determine aided intelligibility for a given hearing impairment: low distortion, wide bandwidth, proper frequency response, and—if AGC is used—appropriate compression characteristics. Until recently, the great majority of hearing aids failed on all counts, with the result that it was nearly impossible to understand speech in noise. Not surprisingly, hearing aids got a bad name.

Zero For Four

When manufacturers tried to correct the problems one at a time, it only made things worse. Extending the high-frequency response without reducing high-frequency intermodulation distortion produced hearing aids which sounded most unpleasant in high-level music or social gatherings. Except for the few hearing aids whose volume control was located at the input, most hearing aids overloaded at 85-90 dB SPL input regardless of volume control setting. The typical 95-100 dB SPL levels produced at parties at which musicians were playing forced the hearing aid into raucous overload all the time. Only by rolling off the high-frequency response did such aids provide marginally tolerable sound quality in such circumstances.



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During the decades when such hearing aid designs were dominant, every laboratory study showed binaural hearing aids were superior to a monaural aid in noise, yet all surveys found users preferred one aid in noise (even though they preferred binaural aids overall). David Hawkins asked why, and Naidoo's study¹ provided an answer. She found that subjects listening in noise to typical asymmetrical peak clipping aids (representing 82% of the aids sold in 1992²) preferred one aid, whereas subjects listening in noise to low-distortion aids preferred binaural aids. This finding held for all types of wideband, low distortion aids: clean Class D linear aids, clean output-limiting compression aids, or wide-dynamic-range-compression with treble-increases-at-low-levels (WDCRC-TILL) aids.

Given the use of a narrow bandwidth to cover up amplifier distortion, no subsequent trimmer adjustment of the frequency response can provide an appropriate frequency response. As Villchur once observed, such adjustments can bring inaudible high-frequency speech cues from well below inaudibility to just below inaudibility.

The need to mask distortion was not the only reason that narrow-band hearing aids made up 82% of our sales. A substantial part of the problem was created by poor impressions, which caused a high percentage of returns for credit and remakes for feedback. The hand-packed, no-block impressions that were adequate when hearing aids had little high-frequency response produced tremendous feedback problems when they were

used for wideband hearing aids. As Teder³ showed quantitatively, rolling off the high-frequency response reduces problems from feedback. Many manufacturers decided that rolling off the high-frequency response was more practical than trying to convince dispensers that their impressions were at fault. Manufacturers are understandably hesitant to criticize inadequate impressions for fear of losing business. (Dispenser: "I've been taking impressions for 15 years. If you can't make good hearing aids with those impressions, I'll go to someone who can!")

A more subtle pressure to reduce the bandwidth of hearing aids comes about because a properly fitted hearing aid restores not only previously inaudible speech cues but also previously inaudible noises. In many cases, the new speech information does little good at first, apparently because the brain loses track of the speech templates for high-frequency sounds⁴. Similarly, the noises are not easily recognized at first, and so the sound of the hearing aids appears to be noisy in the beginning—noisy and perhaps less clear than either the unaided sound or the sound of the previous hearing aids. To less sophisticated dispensers, the obvious solution was to return to the old-fashioned, narrow-band designs. Indeed, two manufacturers told me that their lowest rates of return applied to their plain vanilla (starved-class-A, asymmetrical-peak-clipping, narrowband) hearing aids!

Even manufacturers committed to as-wide-as-practical bandwidth WDCRC-TILL hearing aids have sometimes found it expedient to limit or roll off the low-level high-

frequency gain. For example, the maximum possible 25-dB increase in high-frequency gain at low levels available in one WDRC-TILL hearing aid design has been reduced to 18 dB or less—even at the maximum setting of the threshold-knee trimmer—by some manufacturers in order to facilitate ease of manufacture and minimize returns for credit. To this writer, this seems like delivering a high-power sports car with a brick welded under the accelerator pedal. It may make the car safer for novice drivers, but it also restricts the performance available to the skilled professional. It creates a sports car for the least-common-denominator driver.

Hearing Aids That Do Work

What proof do we have that low-distortion, proper-frequency-response, appropriate-compression-characteristics, wideband hearing aids will improve things? One indication is the fact that once dispensers become skilled at fitting WDRC-TILL hearing aids, they tend to fit 50-80% of their clients with them. This is true for audiologists and hearing instrument specialists alike. The improved client satisfaction shows up most strongly in increased new-customer referrals as the clients tell their friends how much better the wideband, low-distortion aids sound, and how much better they hear in noise. These reports arrive on a regular basis. A recent letter from Germany that reported on 2000 WDRC-TILL (K-AMP®) ITE hearing aids stated: "The spontaneous acceptance on the part of the hearing [impaired] patients was astonishing." As I was writing this article, an audiologist who called me said, "I thought you'd like to hear this: When Mrs. ___ told me how happy she was with her new WDRC-TILL hearing aids, I asked, 'What do you like most about them?' She answered, 'I sleep better at night!' She wasn't kidding; she said she was now much more relaxed during the day and so she slept better at night."

Another positive indication is the improvement in the ability to understand speech in noise—in particular, in the measured signal-to-noise ratio required for 50%

word intelligibility. Killion & Villchur⁵ reported on three subjects wearing WDRC-TILL hearing aids who performed within 2-4 dB of normals. However, one of the same subjects did 6-12 dB poorer than normals when he was tested with his recently purchased traditional (peak-clipping, narrowband) canal aids (*which he hated, not surprisingly*). Both these low-quality canal aids and his high-fidelity WDRC-TILL canal aids (*which he loved*), were made by the same manufacturer. Thus, the *signal processing* and not the manufacturer, appears to be the critical factor. Similar intelligibility results were reported by Professor Kiessling⁶ at the German Otocongress this year. The signal-to-noise ratios his subjects required for 50% correct scores were as follows: 0 dB unaided, -2.2 dB with linear peak-clipping aids, and -5.7 dB with K-AMP aids.

The theoretical explanation for the large improvements cited above is treated elsewhere^{7,8,9}, but was summarized by Pascoe¹⁰: "Although it is true that mere detection of a sound does not ensure its recognition, it is even more true that without detection the probabilities of correct identification are greatly diminished." He might have added that distortion badly degrades intelligibility in noise, as demonstrated again recently by Fikret-Pasa¹¹.

Out With the Old

The present narrowband hearing aids represent the lowest-cost, lowest-return-for-credit products, but they perpetuate the hearing aid stigma. The percentage of such hearing aids is dropping dramatically, however, from approximately 80% at most hearing aid companies in 1992, to less than 50% by the end of 1993, and 20% or less at some companies (personal communications).

The good news is that at least five of the 30-odd manufacturers of WDRC-TILL hearing aids have chosen not to roll off the high-frequency response or restrict the amount of high-frequency gain increase at low levels. They report that after a somewhat painful dispenser-education period, return rates on their full-

bandwidth WDRC-TILL hearing instruments are no higher than normal. In the wrong hands, however, such hearing instruments still create a high rate of return.

A Modest Proposal

No order for wideband hearing aids, especially of the WDRC-TILL variety, should be accepted without:

1) Impressions which are fully formed and extend past the second bend. Without these, wideband hearing aids are simply an invitation to disaster.

2) An assurance that the dispenser is familiar with the counseling requirements which typically accompany the reintroduction—to a hearing impaired client—of previously unheard high-frequency speech cues and noise. ♦

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