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Amplification

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A balance of the low and the high frequencies…

This inaugural column begins with a review of an article that is over 45 years. But despite the age of this article [https://doi.org/10.3109/00206098309072789], it is still cutting-edge and can easily make the difference between a successful and a failed hearing aid fitting.

In the early 1980s, Margo Skinner was completing her PhD at the Central Institute for the Deaf in St. Louis. Many will recall her name- actually Margaret Skinner- from the 1990s, where much of what we knew about cochlear implants came from Margo's research. But back in the 1980s, we were running into the clinical problem of improving speech intelligibility and thinking that we had succeeded, only to find that our clients hated the sound- the speech discrimination ability was improved, but at a cost. Clinically, we had to decide on a fitting somewhere between the clearest and the pleasantest.

During her PhD thesis, Margo had full control of both the low-frequency end and the high-frequency end of the amplification range, while using a "master hearing aid"- essentially a large box with headphones. As could be predicted, increasing the higher frequency range improved speech intelligibility, but when sufficient high-frequency boost was achieved, the only thing that seemed to return the hearing aid to a natural sound was the unexpected introduction of low-frequency amplification. That is, a balance of low frequency *and* high frequency amplification is required in the hearing aid fitting- although this started off as a solution in the 1980s, this is still very much the case today.



Given the current state of affairs, barring cochlear dead regions that limit how much high-frequency amplification a hard-of-hearing person can use, hearing aids can offer substantial gain up to at least 6000 Hz. And a primary reason this doesn't sound poor is that we can now provide our clients with significant low-frequency amplification at the same time.

But, unlike the work of Margo Skinner in the 1980s where she simply turned up a knob to give more bass sound, modern hearing aids have one feature that was not very successful, or even widely available in the 1980s- namely feedback management. Feedback management enables us to achieve significant mid- and high-frequency amplification with an open or non-occluding mold. This allows significant low-frequency sound to bypass the hearing aid, and enter directly through the non-occluding vent.

While the ANSI S3.22 hearing aid specification may yield a low frequency end of the frequency response at 200 Hz or so, additional *unamplified* low frequency sound contributes to the actual increased bandwidth- perhaps with a low frequency end of 125 Hz for speech (the lowest typical fundamental frequency of a man's voice) and down to 55 Hz for music. This added-in unamplified low frequency sound energy balances with the higher amplified sound energy allowing our clients with optimal speech intelligibility, and the highest quality of amplified music- not sure that Margo Skinner had that in mind in the early 1980s, but she was correct!

Reference

Skinner, M. W., & Miller, J. D. (1983) Amplification bandwidth and intelligibility of speech in quiet and noise for listeners with sensorineural hearing loss. Audiology, 22(3), 253–279. https://doi.org/10.3109/00206098309072789