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A Hearing Aid Solution for Music

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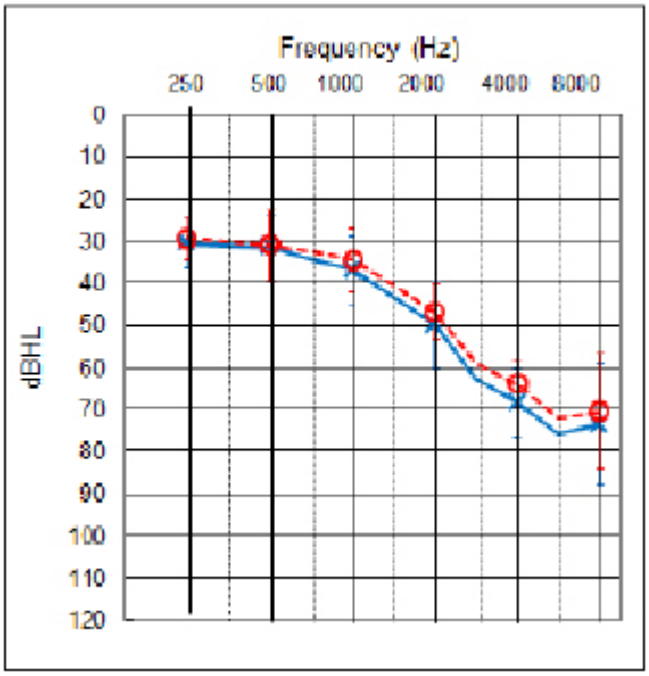


Figure 1. The average audiogram for the 10 subjects, with the standard deviations shown as the vertical bars at the respective audiometric frequencies.

See if this sounds familiar: “I’ve had analog hearing aids for years and my banjo sounded great. They broke recently and I am now trying my fifth set of digital hearing aids. They distort the sound of my music and nothing that the audiologist does seems to help. I am not sure who is more frustrated—me or my audiologist!” I hear this type of comment frequently from musicians and many others. I also hear comments like this from many of my non-musician clients who, on occasion, like to attend concerts and generally like to listen to music.

The problem is *not* in the programming software. Tweaking the frequency response, gain, or compression features will only help if they were set up incorrectly for speech in the first place.

The problem is the *analog-to-digital* (A/D) converter that all digital hearing aids have. The A/D converters are found in the normal microphone route, the telecoil route, the direct audio input route, and (depending on the implementation) the wireless connection routes. The A/D converter is ubiquitous in modern hearing aid technology.

Partly because of the 16-bit architecture that modern digital hearing aids use, and partly because of some engineering design decisions that had to be made (generally to reduce the noise floor),

modern hearing aids cannot handle overly intense inputs—this is typically the case for any input over about 95 dB SPL. This is true of entry level hearing aids and also true of top-of-the-line premium hearing aids. The most intense components of speech are on the order of the 80-85 dBA, so even shouted speech can get through the A/D converter "doorway" into the hearing aids.

The difficulty lies with music and other more intense speech inputs like a hearing aid wearer's own voice. Even quiet music can have its peaks in excess of 95 dBA, and these music elements overdrive the A/D converter (also known colloquially as the "front end of the hearing aid"). Distortion that occurs as a result of A/D converters that are not up to the task of transducing music cannot be undone by software manipulation that occurs later in the hearing aid processing system. This front-end distortion does not respond to changes in frequency response, gain, or the hearing aid compression features that occur later in the hearing aid processing pathway.

The hearing aid industry has responded, in part, to this issue of poor music fidelity. A/D converter stages have been redesigned to "auto-range" or readjust their optimal region of digitization[1-5] and also to utilize less sensitive microphones that "fool" the A/D converter into thinking that it is receiving lower level inputs that are better suited to their digitization parameters.[6,7]

A concern about these approaches is an increased noise floor in hearing aids that some people may hear—especially if their hearing sensitivity is good for the lower frequency regions. In addition, despite modern A/D converters having a theoretical limit of a 96 dB dynamic range (such as 7 dB SPL to 103 dB SPL), very few technologies have even been able to approach this limit.

Recently, a new approach has been introduced to the marketplace where the A/D converter dynamic range is elevated to an input region that is more appropriate for louder inputs such as music—like raising a low hanging bridge. True Input™ technology from Widex is the name associated with a novel approach designed to ensure that the available dynamic range is fully utilized while keeping the noise floor low. In addition, and perhaps most importantly, the technology utilizes a transformer action that allows the *input voltage to be doubled*. This has the effect of extending the top range of the A/D conversion process to 113 dB SPL, which is more appropriate for many forms of music.

Since the late 1980s, modern hearing aid microphones have been able to transduce inputs up to 115 dB SPL without distortion. With this new approach, full use is being made of the wide range of inputs that are available through the hearing aid microphone.