# Keeping It Simple

## The "one-ear aided, one-ear open method" for musical performing

By LARRY REVIT, MA

This brief article addresses the use of hearing aids during loud, onstage music performances with regard —distortion and restricted low-frequency range—with one low-tech strategy: I wear only my left hearing aid, turned down a couple notches, with my right ear remaining open and unaided. However, there is more to be said if the reader is to know the rationale behind that strategy.

First, I have a bilaterally symmetrical sensorineural hearing loss whose ranges can be referred to, more or less, as "mild" in the low frequencies (below 500 Hz), "moderately severe" in the lower mid frequencies (500 to 1000 Hz), "severe" in the upper mid frequencies (1500 to 3000 Hz), "profound" in the high frequencies (4000 to 6000 Hz), and, nowadays, unresponsive above 8000 Hz (Figure 1). These progressive ranges of hearing loss each present a unique set of requirements for optimal gain, equalization, and dynamic range modification. Therefore, a hearing aid with multiple channels of the stated characteristics seems an obvious ideal choice. So that's what I use when I wear one hearing aid while performing on stage.

For my hearing loss, the principal advantage of the "one ear aided and one ear open" method is that the aided ear receives enhanced mid and high frequencies (for which I have a severe hearing loss), while the open ear receives the low frequencies (for which I have only a mild hearing deficit) untreated except for the amplification provided by the onstage amps and monitors.

The low-tech one-aided-ear method is simple enough to implement, for obvious reasons. But, perhaps surprisingly, the strategy overcomes the potential consequences of using two "ordinary" hearing aids: distortion and restricted reproduction of the lowest musical frequencies.

### Distortion

Because of the high input sound-pressure levels (SPLs) of amplified music, the circuitry of a hearing aid worn on stage is subject to overload, causing considerable distortion. However, it is generally not the output circuitry that is most likely to overload; it is the "front end" and the analog-to-digital (A/D) converter that is most likely to distort due to high input levels. The signal to the front end is generally not affected by the volume control (VC) which is placed later in the hearing aid circuitry (ie, turning down the VC won't get rid of distortion).

But if the sound of the hearing aid worn in my left ear is distorted, which it usually is with my hearing aids during loud music performance, then how does leaving one ear open help to overcome the undesirability of the distortion? The answer is that I don't seem to notice the distortion from the hearing aid any more; I used to, but I have learned to ignore it. I believe I have learned to focus on the undistorted signal available to the other, open ear. How do I know that it is not my hearing loss that prevents me from hearing the distortion in the aided ear? Case in point: When I add a hearing aid to the other ear so that I'm now wearing one on each side, I hear lots of distortion from both sides.

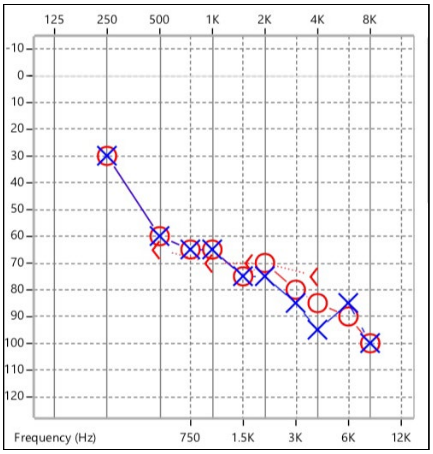
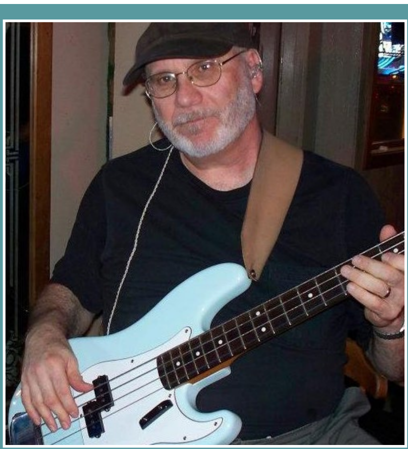



Figure 1. The author's audiogram.



A musician since childhood, **Larry Revit** pursued making recordings as a teen. Beginning with an apprenticeship in commercial recording in 1970, he worked in studios and concert venues until the end of that decade, while concurrently earning a Bachelor of Music degree in "music engineering"—when a progressive hearing loss led to a change of course. He later received a research-oriented master's degree in audiology, and now has come full circle: creating laboratory sound systems used in hearing aid and cochlear implant research. All the while, he has remained a performing musician, playing guitar and electric bass. Correspondence: revitronix@aol.com

### Restricted Low-frequency Range

Instead of leaving one ear open, I would prefer to be receiving well-enhanced mid and high frequencies in both ears during amplified performances by wearing two hearing aids presenting no audible distortion—but only if the hearing aids also had the necessary low-frequency range.

A performing musician strives to produce, among other factors, the correct loudness and timbre of all notes played. An essential requirement, therefore, is that all the frequencies contained within the harmonic structure of a note must be audible to the player, assuming that those frequencies are audible to a normal-hearing listener. Musical pitch can be perceived even if a note does not include the lowest, or fundamental, frequency.[1] However, audibility of the fundamental frequency is essential for perceiving the natural loudness and timbre.

The fundamental frequency of the open-string low E of a 4-string bass is 41 Hz, and 31 Hz for the open-string B of a 5-string bass. Most hearing aids do not reproduce those frequencies. Arguably, "ultra-low" double-digit frequencies may find their way into the ear through an earmold, even when unvented, or else may be perceived by vibration through the listener's body. So it may not be necessary, when the musician has relatively good low-frequency hearing, for the response of one's hearing aid to extend all the way to double-digit frequencies.

But it has been my experience in music performance that most hearing aids with unvented ear pieces function essentially as low-frequency earplugs. To illustrate: Invariably, if I am wearing my hearing aids in both ears when listening to a bass, if I take off even one of them, the perceived sound of the bass gets substantially louder and deeper in timbre than it was with both hearing aids on. So, for accurate perception of the loudness and timbre of a bass, I must keep one ear open — again, relying on the hearing aid in the other ear to give me enhanced mid and high frequencies.

Finally, it is worth noting that the open ear provides not only extended low-frequency response, but also provides information on the untreated dynamics (ups and downs in volume) of the instruments. That is, the musician can benefit from hearing the natural speed and extent of variations in loudness of one's own instrument, and those of the musical ensemble, in helping the musician to play with dynamics that are appropriate. The processing in a hearing aid can obscure the natural dynamics, and so having access to the untreated dynamics via the open ear is important.

Certainly, the many strategies described by the authors in this edition support the notion that better times are here—or are on the horizon—for musicians with hearing impairment. But for the time being, for those currently without the newest technology, at least this simple "stop-gap" solution exists.

## Reference


Moore BCJ. *An Introduction to the Psychology of Hearing.* 6th ed. Bingley, UK: Emerald Group Publishing;2012.


## Recommendations for a "Musicians' Package"

### Potential solutions for distortion

1) The most obvious solution might be for manufacturers to use mic preamps and A/Ds that have more input range. Some new hearing aid models do use such components, but it is hoped that this solution may become the norm, rather than the exception, as technology advances.

2) As stated earlier, the input SPLs of an amplified performance can ordinarily overload the mic preamp and/or the A/D that follows it in the circuit. Therefore, a hearing aid that can "temporarily" reduce the gain of the input stage can be expected to allow higher overall input levels without overloading the mic preamp or the A/D, therefore not causing distortion in the output signal—without using an advanced (extended range) A/D. The reduced level of the input signal can be compensated by extra gain at the output.

3) Low frequencies often create high input SPLs. Thus, similar to the approach described above, a hearing aid that has reduced low-frequency response at the input can also be expected to allow higher overall input levels without causing distortion—also potentially without using an A/D with an extended input range. The natural levels of the low frequencies of the input signal can then be restored using low-frequency boost at the output.

4) In an ideal implementation of the above approaches, the user should be able to select either a "normal" or an "attenuated" input channel using separate programs. This feature could potentially support the convenience and comfort of using the same hearing aid for both speech and music. Such selectability can be important for the performing musician, enabling better audibility of verbal communication between songs (eg, for "call-outs" or other spoken instructions).

5) Program-change buttons or switches are likely the first physical components to fail in the life of a hearing aid. Therefore, physically "beefing up" these controls might be important for musicians who rely on a selectable input response. One solution might be hearing aids whose functions are controlled by wireless devices, which would be less prone to the failure of physical components; however, operating a wireless device in live performance may be too cumbersome.

### Future routes for reduced low-frequency range?

1) For hearing-impaired musicians with relatively low thresholds at low frequencies, substantial venting of the earpiece would potentially transmit the low frequencies to the ear, eliminating the need for one completely open ear. However, for musicians with substantial hearing loss at mid and high frequencies, the gain required for audibility of those frequencies during softer passages would ordinarily result in feedback with a vented earpiece. Anti-feedback software in hearing aids can be undesirable for use with music. A potential futuristic solution might be a physically adaptive earpiece with a vent that opened and closed as required for louder and softer passages, respectively (eg, employing a micro-motor to control the size of the vent opening in real-time.

### Musicians need hearing aid programming software

1) Musicians who would prefer to program their own hearing aids need to have the necessary fitting software and equipment made readily available. Commercial hearing aid dispensers simply cannot take the time to tweak and tweak, and tweak again, the programming of a client's hearing aids — and time is often necessary to arrive a functional result. I generally spend what amounts to days programming my hearing aids, not because I'm an unskilled programmer, but because the number of fine-tuning adjustments (iterations) required to reach a favorable set of settings may approach multiple tens. And each iteration must be verified with experiential listening tests by the wearer, preferably on stage! Only the hearing-impaired musician can perceive the sound of the hearing aids through one's "unique but abnormal" auditory system. At bare minimum, the dispenser would do well to at least listen to the hearing aids by means of a probe-tube microphone and monitor earphones—ideally while presenting music that is at least close to on-stage levels. But can you imagine on-stage levels of test signals in a hearing care office? A clinician who programs a musician's hearing aid would have to be especially skilled at hearing aid programming (or simply have to get lucky) to provide even an acceptable fit. Consequently, having the means (fitting software and equipment) to program one's own hearing aids is absolutely essential for the musician.

2) To be able to program the nuances of music in combination with one's hearing loss, the fitting software of a hearing aid for musicians should have equalization bands that function independently—that is, having steep shoulders — so that adjustments of each band behaves independently of adjacent bands. Case in point: With my current hearing aids, if I increase gain in the 250-Hz band, it results in gain changes up to and beyond 500 Hz. The upper-frequency bands have similar characteristics, as well. Concert sound engineers routinely rely on 1/3-octave independent band equalizers to tune their sound systems. The hearing-impaired musician would benefit from programming software having the similar tunability.