It analyzes its frequency content and splits the incoming signal into separate parallel frequency bands. Once the gain, compression, and so forth in each of these bands have been separately manipulated according to the digital algorithms of the hearing aid, the separate contents of each parallel frequency band are then reunited and sent out to the receiver to be transduced back into acoustic form. Adjustment of separate individual channels in these FFT systems is similar to that of the typical equalizer, with buttons that represent frequency, as shown in Figure 8–3.

In contrast, the "channel-free" technology is said to operate in the "time domain" and does not use an FFT to separate incoming sound into separate frequency channels (Schaub, 2008). Instead, the wideband input is taken as it is, and adjustments in gain are made *extremely rapidly over time* (Plyler, Reber, Kovach, Galloway, & Humphrey, 2013). The desired output frequency response—based on the hearing loss, the fitting method and any other selected option provided by the fitting software—is programmed into the channel-free hearing aid. A quantized value is assigned to each new input sample over time, in accordance with specific output demands that are placed upon it, so as to achieve the desired output frequency response. Each new sample thus quantized is added to *all the other samples* that have been previously quantized, in order to constantly update the *entire* output frequency response *over time.*

One can think of the channel-free hearing aid as an equalizer operating over time (like that shown in Figure 8–3), where the buttons adjust sound over three dimensions: amplitude, frequency, and sharpness. It enables frequency response shaping by updating the frequency response *very rapidly* over tiny, *serial* units of time. This technology would thus enable a "holistic" sculpting of the output frequency response without an apparent channel division.

An advantage for digital hearing aids operating in the time domain is that they present with comparatively very little processing time delay; thus, the gain added to the input produces a minimum of distortion to the output temporal waveform envelope. Furthermore, with channel-free processing, there is less spectral distortion that can occur between adjacent channels (Plyler et al., 2013).

Both channel-free and the more typical multichannel fast-acting WDRC (see Chapter 7) digital hearing aids have been compared for subjective preference and also for objective speech recognition. For subjects with no previous hearing aid experience, Plyler et al. (2013) found no significant differences in subject performance with channel-free versus a seven-channel WDRC hearing aid, on the Hearing in Noise Test (HINT) and the Abbreviated Profile of Hearing Aid Benefit (APHAB). Interestingly, individual subjects did have definite preferences for either the channel-free or for the seven-channel WDRC hearing aid. Plyler, Hedrick, Rinehart, and Tripp (2015) compared performance among experienced hearing aid wearers with channel-free versus the same seven-channel WDRC hearing aid. No statistical difference in consonant recognition in quiet and in noisy listening conditions was found between the two methods of DSP. The investigators also found no significant difference in subjective sound quality preference between the two DSP schemes. A third finding of their study was that previous experience wearing hearing aids did not seem to play a part in the objective performance or subjective preference findings.

In summary, there are always trade-offs to be considered when engineering new digital hearing aids. Again, it behooves clinicians to *listen to digital products with their own ears* and compare sound quality among digital hearing aids before automatically adhering to the claims of the manufacturers who build them. The high-end digital hearing aid from any one specific manufacturer may not necessarily offer the best sound quality. Sometimes, the simpler products, with fewer frequency bands and fewer bells and whistles, in fact can sound quite good! Usually, good old straight linear gain (when not distorted by peak clipping) can also sound quite clean and clear.

AUTOMATIC FEEDBACK REDUCTION

Feedback is one of the major complaints of hearing aid wearers. The classic problem has been that the client turns down the volume of the hearing aid to reduce the feedback; of course, the result is that he or she can then no longer hear effectively. Feedback is caused when aided sound outputs from the receiver