How consumers perceive the differences in the two types of hearing devices

A subjective evaluation of K-AMP™ vs. linear hearing aids

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The K-AMP™ hearing instrument is described by manufacturers as a high-fidelity hearing aid which amplifies quiet sounds, while allowing loud sounds to pass through unamplified. This study measures the subjective evaluation of 40 experienced hearing instrument wearers after they wore K-AMP instruments for two weeks. The subjects were asked to evaluate how well K-AMP instruments and their current instruments performed in several listening situations. When asked their preference between instruments, 55% preferred the K-AMP hearing instruments, 27.5% preferred their current instruments and 17.5% indicated no preference. Implications of the results are reported.

A common complaint of hearing instrument wearers is difficulty understanding conversation in noisy situations. Linear hearing aids amplify speech and noise equally well and do not take into account the phenomenon of loudness growth that is common to many with sensorineural hearing loss. The use of binaural fitting, directional microphones, moving physically nearer to the speaker and multiple, fixed frequency responses in conventional hearing aids have been shown to be effective nonadaptive processing approaches to noise reduction.11

In recent years, many efforts have been made to manufacture adaptive processing circuitry that efficiently addresses the signal-to-noise problem. These include compression limiting, variable compression threshold, pre-filtering, post-filtering, frequency independent compression, directional microphones and etymotic frequency response.1,10 The reader is referred to an excellent review of adaptive processing in noise reduction hearing aids by Sarnthein and Ochs.11

Automatic signal processing (ASP) circuits have been described as a means to sort speech from noise.1,2,3,5,7,8,11 A common problem occurs when compression results in the reduction of gain at all frequencies, so that the intelligibility of soft speech sounds is reduced. Hall and Jacobs2 point out, “The limitation of ASP circuitry is that it does not address the different gains and output requirements of a hearing impaired patient at various pitches as the dynamics of a listening situation change” (page 16).

A common hearing loss configuration results in normal or near-normal hearing in the low frequencies, but a significant decrease in hearing for the higher frequencies. ASP circuits that reduce the gain of low frequency signals may not be maximally beneficial for this type of configuration.

The K-AMP™ hearing aid is designed for hearing instrument wearers with mild-to-moderate and/or sharply sloping high frequency losses who require greater gain for quiet sounds than they do for loud sounds. It is also intended for those desiring good sound quality.

The K-AMP amplifier provides high frequency gain for lower input levels, since the hearing loss for soft sounds is typically greater at high frequencies. Killion, Staab and Preves2 describe the K-AMP with the acronym TILL (Treble Increases at Low Levels). The treble response is automatically reduced for higher input levels.

Manufacturers claim that the K-AMP circuitry is good for patients with tolerance problems, for patients whose listening environments vary constantly or for patients who are often in listening environments where loud noise is present. Overall gain is automatically reduced for high-level inputs, preventing audible distortion under all listening conditions. According to Killion5, “The K-AMP was designed to work without distortion up to 110-115 dB SPL inputs. Many hearing aid circuits are designed to operate only to 90 dB SPL, even at minimum volume control setting. However, many sounds peak at higher levels than 90 dB SPL, making distortion a problem” (page 38).

The frequency range of the K-AMP instrument is from 100 to 14,000 Hz depending on the specifications of the manufacturer. This ability to choose wide bandwidth, in combination with reduced distortion, is intended to enhance speech intelligibility in many listening situations. Various trimpots are available on K-AMP instruments to provide for different fittings. A low frequency cut trimpot can be adjusted to reduce the low frequency gain of the output circuit. A threshold knee trimpot serves to prevent feedback in heavily vented fittings. The threshold knee trimpot, however, may limit gain in quiet settings and subsequently not take advantage of the dynamic range compression capabilities of the instrument. A tone switch is also available on some models to provide a user-controllable low frequency cut in the microphone input circuit. There is a 15 dB gain available in an active circuit in a quiet room that may sound like “circuit noise” to patients with normal hearing in low frequencies. When more ambient noise is introduced to the listening situation, this “circuit” noise is no longer noticeable. Adjustment of venting or a threshold knee trimmer can help to reduce this “circuit noise.” The K-AMP aid also contains a low-battery warning that provides a quiet, low motorboat sound which becomes louder and faster as the battery voltage drops below proper operating value.

Methodology
This study used a one page, four-point index (poor, fair, good and excellent) questionnaire asking respondents to compare the overall performance and clarity of the K-AMP (questions 9 and 10) in eight listening environments (questions 1-8) to the performance of their current hearing aids. (See Appendix). Forty experienced (at least two years of experience) hearing instrument wearers were selected from patients at the Louisville Hearing Aid...
Center, Inc. in Louisville, KY, to use K-AMP instruments for a two-week trial period. All subjects in the study had sensorineural hearing loss. Speech discrimination was in the good or excellent categories (>/=76% in one or both ears) for 92.5% (n = 37) of the subjects (Table 1).

The subjects' current hearing instruments were working properly at the time of the study. None of the subjects indicated dissatisfaction with their current instruments prior to the K-AMP hearing aid usage period. Care was taken to not guide the subjects in stating their preference for the hearing aids. The manufacturers' procedures were followed in fitting the K-AMP instruments. The subjects were fitted with K-AMP instruments in the same format as they wore their current instruments. For example, those wearing a canal aid in the right ear were fitted with a canal K-AMP instrument in the right ear. Twenty-six were fitted binaurally and 14 monaurally. Twenty-one were fitted with Rexton K-AMP in-the-canal (ITC) type hearing aids and 19 with Qualltone Q11 K-AMP in-the-ear (ITE) instruments. The subjects were asked to evaluate how well the K-AMP instruments and their current instruments performed when listening to speech: 1) from a television, 2) at religious services, 3) in a restaurant, 4) in a theater or lecture hall, 5) in a car, 6) in a noisy room, 7) when listening to music and 8) when listening in a quiet environment.

The subjects were asked to rate the overall clarity of speech with each type of hearing aid and to rate the overall performance of each type of hearing aid. The subjects were requested to rate the performance of the hearing aids as poor, fair, good or excellent. They were also asked to indicate which they preferred, the K-AMP hearing aid or their current aid. Some questionnaires were not fully completed; hence, analyses for some questions include less than the total subject number.

Results and Discussion
The first three bars in Fig. 1 indicate that 55% (n = 22) of the respondents preferred the K-AMP hearing aids, 27.5% (n = 11) preferred their current instruments and 17.5% (n = 7) stated no preference between the K-AMP aid and their current instruments. A comparison of the canal and ITE instruments indicated that 57.8% (n = 11) of the canal wearers preferred the K-AMP instruments, 31.6% (n = 6) preferred their current instruments and 10.2% (n = 2) indicated no preference.

![Patient audiometric data, hearing aid type and preference](image_url)

Table 1. The mean audiometric data, word recognition scores and standard deviations for subjects of study.
same listening environment. This suggests that the K-AMP aid provided better performance than their own hearing instruments in this situation, but still has limitations.

The strongest rating for the K-AMP hearing aid was listening to speech in quiet (90%; n = 36) as excellent or good. This was expected, but the rating for the current amplification was only 77.5% (n = 31), substantially lower than the rating for the K-AMP hearing aid.

According to the respondents, the K-AMP instrument seems to perform significantly better than their current hearing aids in restaurants and when listening to television. The excellent or good rating given for K-AMP aids in a restaurant was 67.5% (n = 27) and for the current hearing aids 35% (n = 14). Television listening was rated as good or excellent for the K-AMP instruments by 65 (n = 26) of the respondents and for their current instruments as 3% (n = 12).

Regarding the performance of the hearing aids in religious services, 27 of the 33 who responded (81.8%) rated the K-AMP instruments as excellent or good. Only 30.3% (n = 10) rated their current instruments as excellent or good in this listening situation.

Nineteen of the 30 subjects (63.3%) rated the performance of the K-AMP instruments as excellent or good in a theater or lecture hall. Half of the subjects rated their current instruments as excellent or good in these situations.

Twenty-seven of the 39 subjects (69.2%) who responded to the question about listening to speech in a car rated the K-AMP instruments as excellent or good, and 48.7% (n = 19) rated their current hearing aids as excellent or good in this situation.

Although only 43.6% (n = 17) of the 39 subjects who responded rated the K-AMP hearing aids as good or excellent when listening to speech in a noisy room, the response was significantly better than for the current hearing aids. Only five (12.8%) rated their current instruments as excellent or good for this category.

Thirty of the 37 subjects (81.1%) rated the K-AMP hearing aids as excellent or good, and 67.6% (n = 25) rated their current instruments as good or excellent when listening to music.

In evaluating the clarity of the instruments, 77.5% (n = 31) rated K-AMP aids as excellent or good, while 57.5% (n = 23) rated the clarity of their current amplification as excellent or good.

Only 35 of the 40 subjects rated the overall performance of the two types of hearing aids. Seventy-seven percent (n = 31) rated the K-AMP instruments as excellent or good and 51.4% (n = 18) rated their current hearing instruments as excellent or good.

Conclusions
The subjective acceptance of amplification by those with hearing loss is of great concern to hearing health care professionals. The possibility of functioning comfortably with adequate amplification in many social settings is a vigorously pursued goal of the hearing-impaired population. The development of amplification systems that effectively address the signal-to-noise problem is continually sought by researchers. The recent manufacture of K-AMP circuitry is an effort to provide clarity of speech in noisy situations. The reduction of distortion and increase in comfortable listening at high input levels may be the major benefit of the K-AMP circuitry rather than actual improvement in the signal-to-noise ratio.

References