Acceptable Hearing Aid Throughput Delay For Listeners with Hearing Loss Under Noisy Conditions

Justin R. Burwinkel, Au.D., Martin McKinney, Ph.D., and Jason Galster, Ph.D.
Starkey Hearing Technologies, Inc.

Introduction
Hearing aid processing (e.g., noise reduction, binaural beamforming, etc.), remote microphone communication, and the overall number of frequency bands each contribute to the throughput delay of digital hearing aids.

Methods

Participants:
Nine participants (n=9) with hearing loss were included in the study. Five (n=5) participants wore open-fit hearing aid devices while four participants (n=4) wore devices with a 1 mm acoustic vent, as included in the study. Five (n=5) participants wore devices with a 1 mm acoustic vent, as included in the study.

Participants had hearing loss configurations ranging from mild to profound degrees of hearing impairment. The red line represents hearing thresholds of the participants’ right ear while the blue line represents the hearing thresholds of the left ear. The dotted lines indicate the maximum and minimum hearing thresholds, for either the right or left side, of all participants at each octave and inter-octave frequency (150-8000Hz).

Research Questions:
When comparing hearing aid throughput delays of 4.5, 15, 20, and 25 msec in background noise levels greater than 70 dB SPL:

- Are hearing-impaired listeners able to detect differences between the delays?
- Do hearing-impaired listeners find the delays acceptable?

Participants:
Nine participants (n=9) with hearing loss were included in the study. Five (n=5) participants wore open-fit hearing aid devices while four participants (n=4) wore devices with a 1 mm acoustic vent, as appropriate for the degree and configuration of the individual participant’s hearing loss.

Hearing Aid Devices:
Starkey receiver-in-canal hearing aids were prepared with firmware that allowed throughput delay to be parameterized.

Individual gain settings were fit and verified to meet e-STAT prescription targets based upon the participants’ individual hearing thresholds.

Four memories were programmed identically except for throughput delay:
- Memory 1 contained the standard 4.5 msec delay
- Memories 2-4 contained randomized delays of 15, 20, and 25 msec

The devices were set to the “Omni Directional” microphone mode.

Procedure:
Participants compared hearing aid processing delays, which ranged from 4.5 to 25 msec, in listening conditions where the ambient noise level was ±70 dB SPL.

Perceptual sound quality was rated, independently, for the participant’s own voice as well as for the speech of others.

The subjective ratings were based upon the relative differences between the 15, 20, and 25 msec delays in comparison to the 4.5 msec condition.

For each rating, the participants assessed the ambient noise level using a calibrated sound meter App on an Apple iPod Touch.

Results

Detectable differences:
Less than half of the participants were able to detect differences in throughput delay, even at the longest delay of 25 msec

Acceptability of perceived differences:
For those who could detect differences across the delay conditions, there was a trend for the 25 msec delay condition to be somewhat less acceptable than the other delay conditions.

Relationship with ambient noise level:
Detectable differences were increasingly reported as the degree of throughput delay increased, particularly when ambient noise levels were at their lowest.

Summary

- Less than half of the participants were able to detect differences in throughput delay, even at the longest delay of 25 msec
- When differences in throughput delay were detected, most were still rated as being “acceptable” to the hearing impaired listeners
- Detectable differences were increasingly reported as the degree of throughput delay increased, particularly when ambient noise levels were at their lowest
- Our data suggest that, under noisy conditions, hearing aid wearers will tolerate throughput delays that are longer than those conventionally recommended
- Future work will examine the impacts of throughput delay on speech intelligibility with changing environmental conditions

References