Methods

Participants

Sixteen adults aged 52 to 81 years (mean = 68.5 years) with mild to moderately-severe, sensorineural hearing loss participated in this study. Ten out of sixteen participants were regular hearing aid wearers and none had remote microphone experience. All participants were financially reimbursed for their participation in the study and completed an informed consent process that reviewed study objectives, their required involvement, and any risks or benefits.

Devices

Commercially available behind-the-ear (BTE) hearing aids, remote microphone systems, and programming software from three hearing aid companies were used in this study. Each bilateral set of hearing aids was paired with the respective, compatible remote microphone system(s). All participants were fitted with occluded, full shell custom earmolds; each earmold was used a standard size 13 tube.

Verification

Real-ear measurements were completed using an Audioscan Verifit. All hearing aids were prescribed to an age-appropriate NAL-R target (Sekulé et al., 2006). Remote microphone transparency was confirmed for all fittings, ensuring that the hearing aid output matched prescribed targets in all test conditions. Verification of the remote microphone in situ output was done at test condition distances to allow for contribution of the direct acoustic pathway to the measurement. When the test condition combined the hearing aid microphone with the remote microphone, the audio mixture was set to equal levels for both inputs.

Test Material

The hearing in noise test (HINT) was used in its adaptive form during which the noise was presented at a fixed level (55 dB SPL) and the sentence levels were varied depending on the accuracy of the listener's response. The HINT SNR-50, or the signal-to-noise ratio required for correct repetition of 50% of the sentences, was recorded for the hearing aid only, remote microphone only and hearing aid microphone plus remote microphone conditions. Each condition was assessed one time using two lists (20 sentences for each list). Testing was done over two visits. Three microphone conditions for each remote microphone system were evaluated at each visit: hearing aid only, remote microphone only and remote microphone plus hearing aid microphone. The HINT sessions were at least two weeks apart to mitigate any learning effects.

Test Conditions (26 Total)

1.) Unaided (6 Feet and 12 Feet)
2.) Omnidirectional Hearing Aid Microphone Only (6 Feet and 12 Feet; 3 different rates of hearing aid)
3.) Remote Microphone Streaming Only (6 Feet and 12 Feet; 4 remote microphone systems; remote microphone/hearing aid mix)
4.) Remote Microphone Streaming + Hearing Aid Microphone (6 Feet and 12 Feet; 4 remote microphone systems; remote microphone/hearing aid mix)

Results

Results

Four RMADVeRks were compiled for the conditions shown in Figures 2-5; each showed a significant main effect of microphone condition: F(7,105) = 233.5, p < 0.001 for six feet remote microphone only; F(7,105) = 202.2, p < 0.001 for 12 feet remote microphone only; F(7,105) = 144.9, p < 0.001 for 6 feet remote microphone plus hearing aid microphone and F(7,105) = 214.8, p < 0.001 for 12 feet remote microphone plus hearing aid microphone. Post-hoc analyses used Tukey's pairwise multiple comparison test, meaningful observations are discussed below.

Performance with remote microphone streaming significantly increased speech recognition in noise when compared to the hearing aid only condition across all four remote microphone systems when participants were seated both 6 feet and 12 feet from the talker (p < 0.001). Performance with the combination of remote microphones and hearing aid microphones significantly increased speech recognition in noise when compared to the hearing aid only condition across all four remote microphone systems when participants were seated both 6 feet and 12 feet from the talker (p < 0.001). No difference was observed between remote microphone only performance when participants were seated both 6 feet and 12 feet from the talker (p > 0.05).

Performance was similar between the three of the four remote microphone conditions when the hearing aid microphone was introduced.

Discussion

The results of this study agree with previous reports of remote microphone benefit. Participants in this study demonstrated significantly improved speech recognition in noise when comparing remote microphone streaming, both with and without the hearing aid microphone activated, to hearing aid only and unaided listening. This benefit was observed with all four of the tested remote microphone systems.

As expected, distance between the participant and talker did not affect the benefit that the participants received. However, it was unexpected that performance was similar when comparing remote microphone test conditions with and without the hearing aid microphone activated. Previous reports of this comparison suggest that remote microphone benefit would decrease with activation of the hearing aid microphone (Boothroyd & Gilmer, 1996); Krstevska et al. (2007) speculates that the noise levels used in this study were not sufficiently high to cause the expected effect. Future studies using a test protocol that allows for higher noise presentation levels may reveal this effect.

Though not discussed in detail here, the observed benefits were acoustically predictable in nature. Of clinical note, proximity of the remote microphone to a talker’s mouth greatly affects the quality and level of the transmitted signal. Use of any remote microphone technology should include counseling on proper use and orientation.

References


