Benefits of Assistive Listening Devices for Scoring Word Recognition Tests

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INTRODUCTION

The ability to discriminate between phonemes with high-frequency components greatly affects word recognition in noise. Research has shown that hearing loss and increased age can affect high-frequency phoneme recognition abilities.[1] Therefore, the exploration of Assistive Listening Devices (ALDs) to help patients and clinicians with hearing loss communicate in real-world environments is important. [2] One condition of particular importance is when audiologists are required to score speech recognition in noise abilities of patients seated in a sound booth. For audiologists with hearing loss (HL), scoring speech recognition in noise tasks when patients are seated in a sound booth may be facilitated through the use of a remote microphone on the patient and a streamer/hearing aids on the audiologist.

RESEARCH QUESTION

The purpose of this study was to evaluate if individuals, especially those with hearing loss, could use ALDs to increase accuracy of scoring patient responses during audiological evaluations.

PARTICIPANTS

- Ten participants with normal hearing (NH), ages 21 to 55
- Eight participants with HL, ages 21 to 53 years as shown in Figure 1

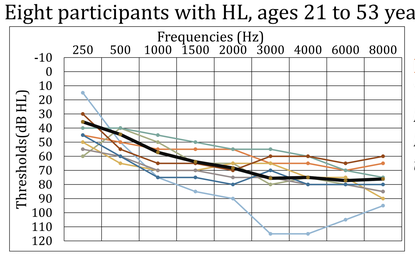


Figure 1. *Audiograms of Better Ear Thresholds of Participants with Bilateral Sensorineural Hearing Loss. Pure tone averages ranged from 47 to 72 dB HL. (n=8).*

EQUIPMENT

Word recognition scores (WRS) were obtained in the typical audiometric setup using Grason Stadler 61 audiometer with monaural monitor headset outside the booth and a patient response microphone inside the booth. Additional equipment used in the testing is shown in Figure 2 and included Phonak Audeo V90 Receiver-in-the-Ear (RITE) hearing aids and a Phonak wireless Roger system.

Hearing Aid *Streamer* *Transmitter*

Phonak Audeo V90 Receiver-in-the-Ear (RITE) *ComPilot II & Roger receiver* *Roger Pen*

Figure 2. *Hearing Aid, Streamer, and Transmitter.*

HEARING AID FITTING

- Participants were fit with HAs with local microphones disabled for streaming
- NAL-NL1 gain and output targets were met within 3 dB of participants' hearing loss; or a flat 10-dB HL representation of NH as verified with a Verifit Audioscan Hearing Instrument Fitting System
- Electroacoustic measures using the Verifit confirmed HAs within expectations for normal function based on ANSI S3.22 measurements

TEST ARRANGEMENTS

- As shown in Figure 3, a KEMAR with Mouth Simulator was set up in inside the soundbooth in far-field, where a patient is placed for sound-field testing.
- KEMAR was fitted with each microphone for the respective conditions.
- Recorded speech stimuli were presented at 75 dB SPL as measured at the transmitter microphone.
- Participants were seated outside the sound booth at the audiometer.

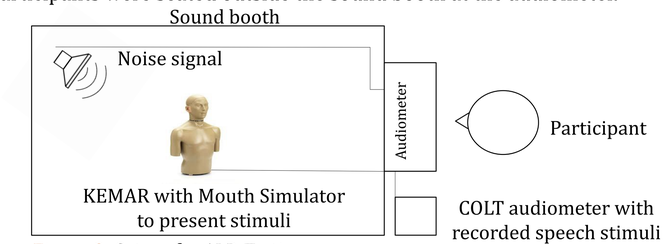


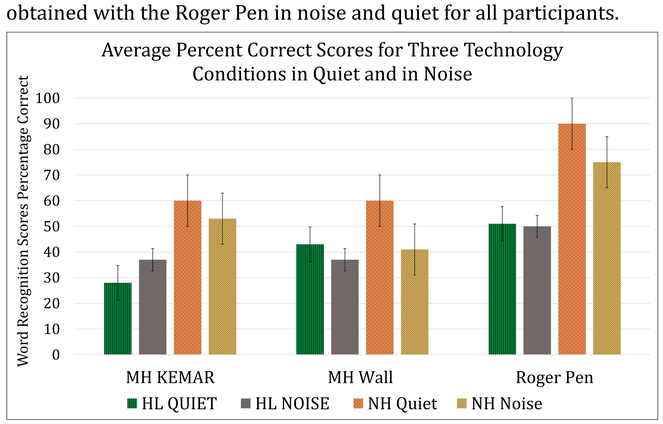
Figure 3. *Set-up for ALD Testing.*

PROCEDURES

- Three technology conditions were tested in quiet and in multi-talker babble noise presented from the rear speaker:
  1) Monitor headset over the RITE HAs with the response microphone placed on KEMAR's chest (MH KEMAR)
  2) Same as above but with response microphone placed above the sound booth window on the Wall (MH WALL)
  3) Roger Pen microphone on KEMAR's chest transmitting to receiver/ComPilot II(ROGER PEN)
- For each condition, one NU-6,[5] 25-words without carrier phrase list was presented.
- To avoid ceiling and floor effects, signal-to-noise ratios were determined based on individual performance on ten difficult words on NU-6 words.[5]
- SNR was increased or decreased so that performance was within a 30 to 70% range and then remained there for the testing of the technology conditions.
- Participants wrote their responses on scoresheets for all conditions.

RESULTS

Performance on the three technology conditions in quiet and in noise for participants with normal and impaired hearing is shown in Figure 4. The best performance was obtained with the Roger Pen in noise and quiet for all participants.



Note: HL=Hearing Loss; NH=Normal Hearing; MH KEMAR=Monitor Headset with response mic on KEMAR; MH Wall=Monitor Headset with response mic placed above sound booth window on the wall; Roger Pen microphone on KEMAR's chest transmitting to receiver/ComPilot II.

Figure 4. *Average percent correct scores for three technology conditions in quiet and in noise.*

STATISTICAL ANALYSIS

- All percent correct scores were arcsine transformed prior to statistical analysis to normalize the distribution of percent correct data.[3]
- A one-between, two within repeated measures ANOVA revealed significant main effects of Hearing Group ($p<0.01$), Technology Condition ($p<0.001$), and Noise Condition ($p<0.02$).
- As expected, participants with hearing loss scored significantly lower than those with normal hearing and scores were significantly lower in the babble condition compared to quiet condition.
- Because there were significant interactions for Noise Condition and Hearing Group and Noise Condition and Technology Condition, a post-hoc analysis of Benefit Scores was performed. Given the Babble noise condition was of the greatest interest, two benefit scores were determined by using the standard audiological arrangement as the baseline (MH WALL).
- By comparing scores obtained in MH KEMAR and ROGER PEN to the baseline (MH WALL), the relative benefit of these arrangements could be determined. A paired t-test showed significantly greater improvement in scoring accuracy was achieved when the ROGER PEN (25%) was used compared to moving the response mic to KEMAR (7%) ($p<0.0008$).

SUMMARY AND DISCUSSION

It was hypothesized that audiologists with hearing loss and/or increased age could improve their accuracy in scoring word recognition tests in clinical practice using ALDs.[2] The results of participants with normal and sensorineural hearing loss showed significant benefit with the Roger Pen when scoring word recognition testing presented in babble noise in typical clinical testing arrangements. These benefits could be even greater when combined with context clues, speechreading skills, and other various communication strategies.[4] It is also noteworthy that the participants only had a 30-minute adjustment to the amplification and further improvements may be observed with individuals' personal hearing aids to which they have adjusted. Furthermore, direct connections such as Roger receivers attached to hearing aids may enhance the benefits received. These results provide support that ALDs can help close the gap in hearing handicaps, ease listener fatigue, and add to overall enhanced quality of life.

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