Automated Forced-Choice Word-Recognition Tests*

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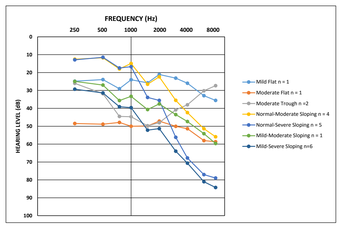
Introduction

Open set and closed set automated speech-recognition tests were constructed and evaluated with ten normal-hearing listeners and twenty listeners with sensorineural hearing loss. Speech-recognition thresholds were measured with CID W-1 recordings of spondaic words in a four-alternative forced-choice paradigm. Word presentation levels converged on the 50% point of the recognition-performance function (SRT). SRTs were compared to pure-tone averages obtained by automated audiometry. Word-recognition tests were conducted with recorded NU-6 monosyllabic words (VA recordings, female talker) at five presentation levels using four-alternative closed-set and open-set responses.

Methods

Subjects:

- One ear of 10 young adults with normal hearing
- One ear of 20 adults with sensorineural hearing losses (see Figure)
- 10 females (18-70 yrs, mean=57.7 yrs, median=62.5 yrs)
- 10 males (46-79 yrs, mean=62.8 yrs, median=64.5 yrs)
- Normal tympanogram and otoscopy



Average audiograms for each audiometric configuration of the 20 subjects (from Margolis & Saly, 2008).

Procedures:

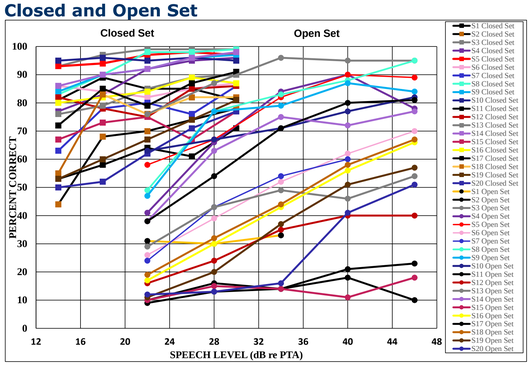
- Air and bone conduction pure-tone thresholds were obtained using the Automated Method for Testing Auditory Sensitivity (AMTAS).
- Audiograms classified by AMCLASS (Margolis & Saly, 2007). (See Figure above)
- Speech Recognition Thresholds were measured with four-alternative closed set responses. Subject chose one of four spondees shown on the touchscreen. Levels were changed adaptively to converge on 50% correct identification of recorded spondees (VA W-1 recordings, female talker).
- Word-recognition tests (WRT) were conducted with recorded NU-6 monosyllabic words (VA recordings, female talker) at five presentation levels using four-alternative closed-set and open-set responses (see table below). 100 words were presented at each level for open set and closed set conditions.
- Presentation levels were referenced to the pure tone average (0.5, 1.0, 2.0 kHz) or average of best two if there was a 20 dB difference between any two of the three.
- Open set responses were verbal responses scored by the tester.
- Closed set responses were pointing responses to a matrix showing four rhyming alternatives.

Presentation levels for Word Recognition Tests

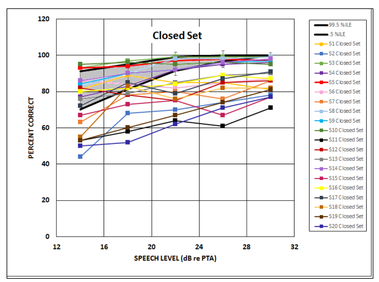
Modality	Speech Level (dB re: PTA)				
Open Set	22	28	34	40	46
Closed Set	14	18	22	26	30

Results

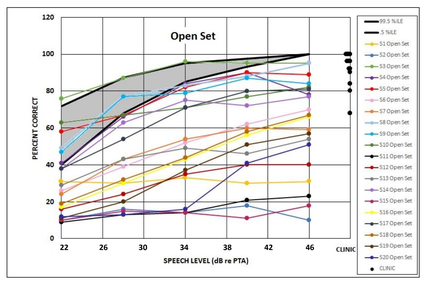
Word Recognition – Closed and Open Set



Closed set and open set word recognition score for 20 listeners with SNHL..

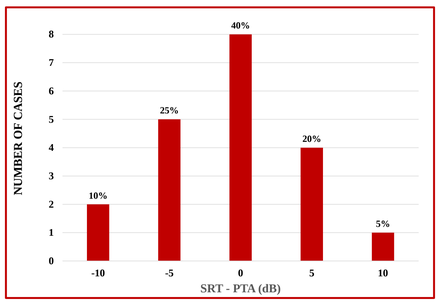


Closed set word recognition score for 20 listeners with SNHL.
The shaded area is the 99% confidence interval for normal-hearing listeners.

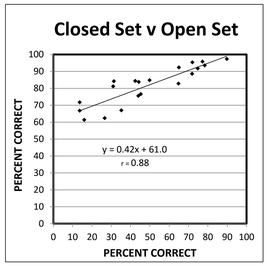


Open set word recognition scores for 20 listeners with SNHL.
The shaded area is the 99% confidence interval for normal-hearing listeners.
Clinic scores are severely compressed relative to the open set scores obtained with the VA (female talker) words.

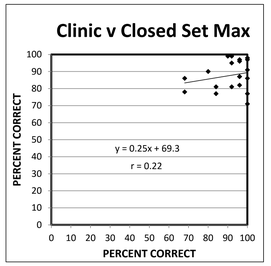
Speech Recognition Threshold



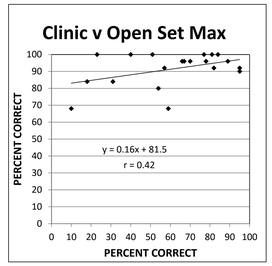
Differences between Speech Recognition Threshold and Pure Tone Average.



Closed set v. open set word recognition scores for 20 listeners with SNHL. Scores were averaged over all five speech levels. Closed set and open set scores were highly correlated.



Clinic v. closed set word recognition scores for 20 listeners with SNHL. Clinic scores were poorly correlated with closed set scores.



Clinic v. open set word recognition scores for 20 listeners with SNHL. Clinic scores were poorly correlated with closed set and open set scores.

Summary of Results

- Open set and closed set word recognition scores for normal hearing subjects are tightly distributed with maximum scores reaching 100% at the highest levels tested.
- Open set and closed set scores for hearing-impaired subjects are widely distributed with maximum scores reaching 100% for a few subjects but with much lower maximum scores for most subjects.
- Distributions of word recognition scores obtained from clinic records are compressed with most scores near 100%, suggesting much better performance compared to open set and closed set scores obtained in this study.
- Average open set and closed set scores were highly correlated (r = 0.88).
- Maximum open set and closed set scores were poorly correlated with clinic scores.
- Speech recognition thresholds obtained with a closed set response agreed well with the pure tone average.
- 85% of differences between speech recognition thresholds and pure tone averages fell within a range of 0 dB ± 5 dB.

Conclusions

- Open set and closed set scores of hearing-impaired listeners obtained with female talker recordings indicate a higher degree of speech recognition difficulty than clinic scores obtained at a single level with a male talker.
- The open set and closed set scores obtained in this study correlate poorly with clinical measures.
- Closed set scores can be obtained efficiently in an automated forced-choice paradigm.
- Speech recognition thresholds obtained with a closed set paradigm agree well with the pure-tone average.
- 85% of the differences between speech recognition threshold and pure tone average fall within a 10 dB range.

References

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* Corrections were made to this poster on 8 April 2016

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