PRESTO: Preliminary Findings with a New High-Variability Sentence Recognition Test in Patients with Cochlear Implants

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INTRODUCTION

• Speech in noise continues to be one of the most common problems facing patients with cochlear implants.
• To perform well in everyday noisy environments, listeners must quickly adapt, switch attention, and adjust to multiple sources of variability in both the signal and listening environments.
• Sentence recognition tests in noise are useful for assessing speech recognition abilities because they require a combination of basic sensory/perceptual abilities as well as cognitive resources and processing operations.
• PRESTO (Perceptually Receptive English Sentence Test Open-set) was developed at IU as a sentence level test of speech perception that:
  - More closely approximates real-world communication with multiple talkers.
  - Engages more cognitive processing resources.
• Does not reach ceiling levels of performance in quiet, to allow for analysis of individual differences.
• Differs from other sentence recognition tests because target sentences differ in talker, gender, and regional dialect.

The goals of the current study were:
1) To compare PRESTO to two conventional clinical tests of sentence recognition (AzBio and HINT) presented in quiet and multi-talker babble.
2) To explore the relationship between demographic, cognitive, and self-assessment measures with sentence recognition in order to characterize the underlying information processing skills associated with speech perception in adverse conditions.

METHODS

Subjects
Seventeen, post-lingually deafened, adult cochlear implant users participated in this study. Patient demographics provided in Table 1.

Materials
• PRESTO (Gilbert et al., 2013): Lists of 18 sentences from the TIMIT Sentence database (Garofolo et al., 1993). Each list contains variation in syntactic structure & length, key word familiarity, lag frequency, talker dialect & gender.

The Speech, Spatial, and Qualities of Hearing Scale (SSQ - Gatehouse & Noble, 2004)
• Self-report scale designed to assess auditory disability in a wide variety of listening situations. 49 questions cover many aspects of speech perception, spatial hearing, and more general qualities of hearing. See example of one item on right.

Procedure
• Subjects were tested in a sound-treated booth, seated 1m from a single loudspeaker at 0° azimuth.
• All auditory stimuli presented at 65 dB; noise condition: 10 dB SNR, 6-talker babble.
• Subjects were tested using their own clinical map on their preferred “everyday” setting with volume set at a comfortable level.
• Presentation of sentence tests were randomized for each subject, one list per condition, quiet preceded noise testing (6 lists total).
• For statistical analysis, percent correct scores were transformed to normalized area units (RAU) (Studebaker 1985) to normalize variance across the range of scores and reduce ceiling effects.
• All noise conditions included two unscored practice sentences at -10 dB SNR.
• Auditory working memory span test presented at 65 dB, 2 lists at each list length (2-10 items).
• Single-sentence recognition testing followed SPAN.
• Subjects completed SSQ using paper/pencil format during testing session.

RESULTS

I. Sentence Recognition

• Mean performance on sentence tests for quiet (left) and noise (right). Test material indicated by color (see legend: HINT, AzBio, and PRESTO). Error bars indicate 95% confidence intervals.
• A repeated measures ANOVA was used to test for differences among test material and noise condition. There was a significant main effect of test material, F(3,54) = 8.277, p < .001. There was a significant main effect of noise condition, F(1,18) = 4.131, p < .05. There was a significant interaction between test material and noise condition, F(3,54) = .973, p < .05.
• Mean performance decreased as a function of test material, HINT > AzBio > PRESTO in both quiet and noise conditions.

Figure 1. Mean Sentence Recognition.

II. Working Memory Capacity

• Sentence recognition was highly variable across test materials and noise conditions. Subjects performed best in the quiet conditions for each of the three tests.

Figure 2. Individual Subject Performance on Sentence Recognition.

• As expected, scores decreased as a function of test material, with digits > letters > words > spondees. All subjects, even those with very poor word recognition, could complete digit span testing.

Figure 3. Mean SPAN Scores.

• Mean SPAN points for digits (r=.47), letters (r=.48), words (r=.45), and spondees (r=.65). Error bars indicate 95% confidence intervals.

Figure 4. SPAN and Sentence Recognition.

• Performance on HINT in Quiet as a function of Digit Span (left panel) and HINT in Noise as a function of Digit Span (right panel). HINT plotted as a representative example. Solid lines indicate best fit regression, and y values indicated in plot.
• All working memory SPAN tests (digits, letters, words, and spondees) were highly correlated with all sentence recognition tests both in quiet and noise.

Figure 5. Mean Total SSQ Self-Report Scores.

• Mean self report scores for each of three subscales: speech, spatial, and qualities of hearing. Error bars indicate 95% confidence intervals.
• Lower scores indicate higher perceived handicap, indicating the greater difficulty with scenarios related to speech perception, and the least difficulty with quality of sound.

Figure 6. Self-Report and Sentence Recognition.

• Performance on PRESTO in noise plotted as a function of self-reported responses to each subscale. Speech (left), Spatial (middle), and Qualities (right). Solid lines indicate best-fit linear regression.

CONCLUSIONS

1) As expected, sentence recognition performance was highly variable across subjects. All subjects showed best performance on tests in quiet. Performance decreased as a function of test material - HINT > AzBio > PRESTO.

2) PRESTO is feasible in high-performing CI patients and is a meaningful assessment to add to the clinical toolbox. Additionally, PRESTO may be useful for candidacy evaluations and to evaluate performance over time.

3) All measures of working memory capacity were strongly related to all measures of sentence recognition performance, both in quiet and noise.

4) While the SSQ self-report total score did not correlate, individual questions were reliable predictors of sentence recognition performance.

Selected References

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