Effects of Linguistic Context in Speech on Release Time Advantage

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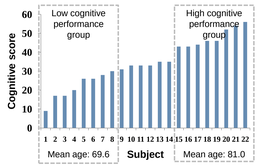
Better speech recognition performance with one type of release time

INTRODUCTION

Release time (RT) of a compression hearing aid (HA) has considerable impact on how speech signals are amplified. Recent research has explored a connection between RT advantage and HA wearers' cognitive status for RT prescription. Findings were contradictory. Cox and Xu (2010) suggested that linguistic context of speech test materials used in previous research was one of the factors that could possibly account for the inconsistency. The purpose of the current study was to address the relationship between cognitive abilities and speech-recognition performance with short and long RTs when speech materials with different amount of linguistic context were used.

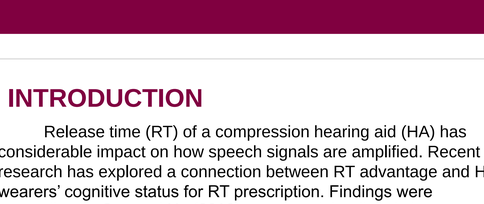
METHODS

This study was a double-blinded crossover study. Twenty-two experienced HA users with symmetrical mild to moderate sensorineural hearing loss were tested. Preliminary analyses were based on 8 cognitively low performance subjects and 8 cognitively high performance subjects.



A. Subjects

- Participants: 16
- Age: 54~91 (m=75.3, SD=10.8)
- Gender: 5 F and 11 M
- HA: 12-channel, WDRC BTE with adjustable RT setting (short: 50ms and long: 2000ms). HAs were bilaterally fitted using the NAL-NL1 method (Kneepoint<50 dB SPL; CR<3). Mean real ear aided responses are shown below.



B. Test materials

- ***Cognitive test***: Reading span task (Rönnberg et al., 1989)
- ***Speech recognition tests***:

- Word-in-Noise (WIN; Wilson, 2003)
- Bamford-Kowal-Bench Speech-in-Noise (BKB-SIN; Etymotic Research, 2005)
- American Four Alternative Auditory Feature (AFAAF; Xu &Cox, 2010)

	Test format	Masking noise	Linguistic context
WIN	Open-set	6-talker babble	Low
BKB-SIN	Open-set	4-talker babble	High
AFAAF	Closed-set	Speech spectrum noise modulated by the envelope of a 6-talker babble	Intermediate

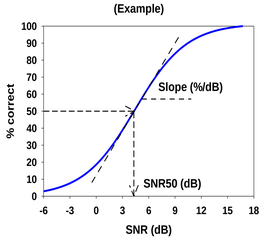
C. Procedures

The three speech recognition tests were administered in the sound field in a double-walled sound room with each RT setting. Percent correct scores were obtained in several SNRs with the presentation level at about 65 dB SPL.

DATA MANAGEMENT

- **Performance-Intensity (PI) function**:

For each subject, a 3-parameter sigmoid equation was fitted to the discrete data points obtained in each test for each RT. The PI functions were not forced to reach 100% correct.



- **Dependent variables**:
  (1) the SNR at 50%-correct performance (SNR50);
  (2) the steepest slope of the PI function (Slope).
- **Grouping variable**:
  reading span score (Group).

A mixed model analysis of variance was employed for examining the interaction between cognitive abilities (Group) and RT (SNR50 and Slope) for each of the speech recognition tests.

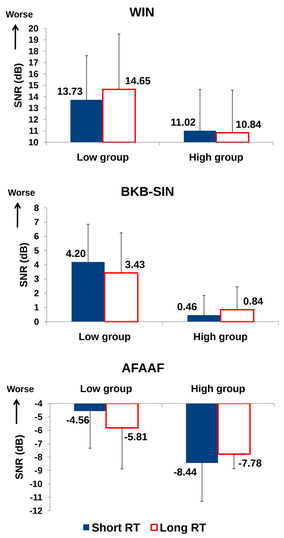
RESULTS

Three hypotheses were tested:

(1) RT is more important for HA users with low cognitive abilities;
(2) HA users perform better with shorter RTs when speech is low in context and perform better with longer RTs when speech is rich in context;
(3) RT advantages measured with the AFAAF replicate findings reported in Gatehouse et al. (2003).

Results from each dependent variable were shown as the following. Statistically significant effects were not obtained possibly due to the small number of subjects.

A. SNR50



❖ Lower SNR50 scores represent better speech recognition performance. In general, the high cognitive performance group performed better than the low cognitive performance group regardless of test materials.

❖ The subjects with high cognitive performance showed smaller difference between the short and long RTs than their low cognitive performance counterparts when tested with all three speech recognition tests.

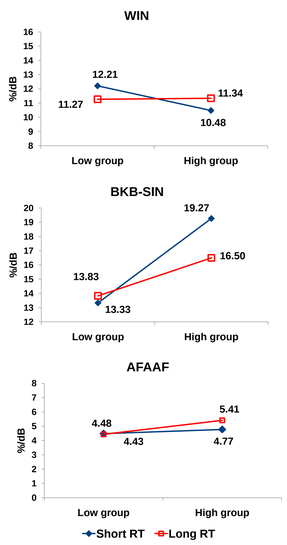
❖ The subjects with low cognitive performance showed better performance with the short RT when tested with the low-context material. Whereas, they showed better performance with the long RT when tested with the high-context material.

❖ When the AFAAF was used, the low cognitive performance group did better with the long RT, while the high cognitive performance group did better with the short RT.

B. Slope

❖ Higher slope values (steeper slope) represent greater change in speech recognition performance when SNR changes.

❖ Regardless of test materials, slope differences between the two RTs are small for both groups (<3%/dB).



DISCUSSION

In terms of SNR50, RT advantage is larger for HA wearers with lower cognitive abilities and smaller for HA wearers with higher cognitive abilities. This finding is consistent with the first hypothesis.

In terms of SNR50, HA wearers with lower cognitive abilities tend to perform better with longer RTs when speech is rich in context and perform better with shorter RTs when speech is low in context. HA wearers with higher cognitive abilities do not show the same pattern and the difference between short and long RTs are very small. This finding is partially consistent with the second hypothesis.

Results from the SNR50 measurement of the AFAAF reveal that HA wearers with lower cognitive abilities perform better with longer RTs, while HA wearers with higher cognitive abilities perform better with shorter RTs. This finding is consistent with results from Gatehouse et al. (2003), in which the British FAAF was used. Thus, this finding is consistent with the third hypothesis.

The three hypotheses are not supported by the preliminary results from the analyses of Slope. RT advantage measured with Slope is small for all three speech recognition materials and the pattern of RT advantage is not clear.

The preliminary results found in the present analyses are based on part of the collected data. More solid conclusions will be drawn after all data are collected from 34 subjects.

CONCLUSIONS

Results from this preliminary analysis are consistent with the hypotheses that (1) RT is more important for listeners with lower cognitive abilities than for those with higher cognitive abilities; (2) the most advantageous RT depends upon the characteristics of the speech signal, implying that the test material could be a biasing factor in evaluating RT advantage.

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