New insight regarding psychometric functions of dual-task paradigms

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INTRODUCTION

- Dual-task experiments, which require the listener to simultaneously perform a primary speech recognition task and a secondary task, have been widely used to quantify **listening effort**.
- The purpose of this study was to characterize the psychometric functions, which describe the performances of the speech recognition task and the secondary task as the function of signal-to-noise ratio (SNR), for younger adults with normal hearing.

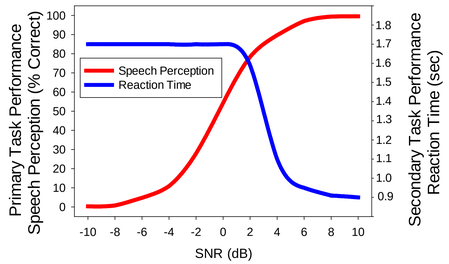

Figure 1. Hypothetical model for a dual-task paradigm using reaction time as the measurement of the secondary task

METHODS

Subjects

- Twenty-four adults/ Ages 19-30 (mean = 23.4)/ 12 Males, 12 Females
- Normal hearing and color vision, and native English speakers

Procedures

- All subjects completed dual-task trials at 11 SNRs ranging in 2 dB steps from -10 to +10 (referenced to individual SNR50)
- The dual task involved pushing a button in response to visual stimuli and then repeating a target sentence. There were two levels of difficulty to the secondary task.

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METHODS

Procedures Continued

- Each subject's SNR50 for word was determined using the Hearing In Noise Test (HINT)
- All subjects practiced the secondary visual reaction task at Easy and Hard difficulty levels (Fig. 2)
- Subjects were asked to press a button as quickly as possible in response to a stimulus appearing on the computer screen
  - Hard: Participants pressed a button in response to the color they saw, rather than the color meaning (Stroop Test)
  - Easy: Participants pressed the space bar in response to the stimulus, no matter the color
- Upon mastery of the secondary task, the primary, speech perception in noise task (20 HINT sentences) was added
- Participants rated their listening effort

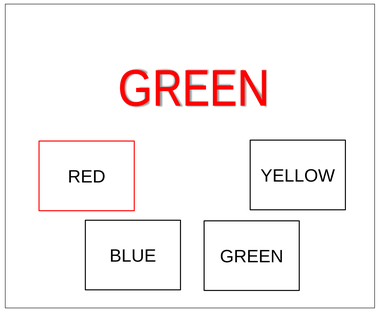

Figure 2. Computer screen shot of the Hard visual reaction task

Scoring

- Speech Perception : Percent of correctly repeated words
- Visual Response Task: Reaction time (RT) to stimuli appearing on computer screen
  - For a given subject, RT was converted to a z-score

RESULTS

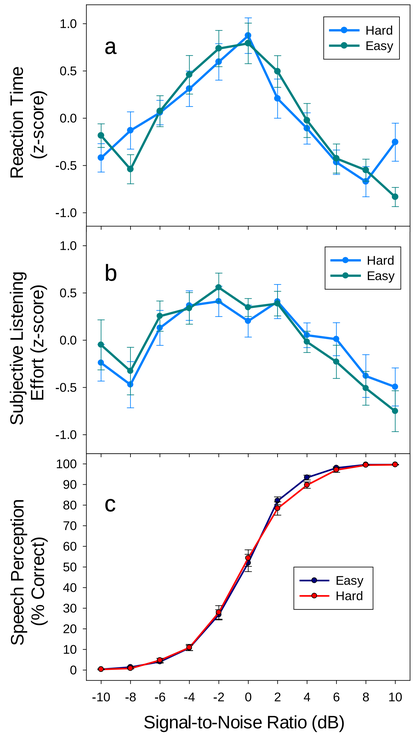

Figure 3a, 3b, and 3c. Reaction time (3a), subjective listening effort rating (3b), and speech perception scores (3c) as a function of SNR

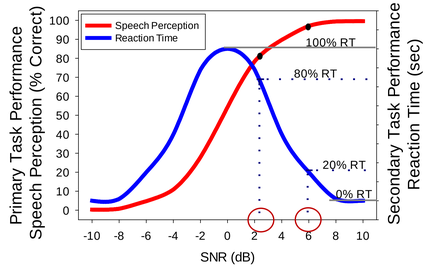

Figure 4. Method of obtaining data for Table 1

RESULTS

	Hard	Easy
SNR (dB): 20%RT	4.28 (2.71)	2.90 (2.82)
SNR (dB) : 80%RT	0.96 (1.79)	0.79 (1.89)
Speech (%): 20%RT	87.65 (13.11)	81.13 (19.86)
Speech (%): 80%RT	65.98 (19.94)	66.02 (21.60)

Table 1. Signal-to-Noise Ratios and Speech Perception scores for each secondary task difficulty level at the 20% and 80% Reaction Times (RT)

DISCUSSION

The results indicated that RT did not increase asymptotically as SNR became lower (poorer) and as speech performance became worse. The psychometric functions of the secondary task were not simple reverse-sigmoid shapes mirroring speech recognition performance. Instead, the secondary task psychometric functions were peak-shaped. As SNR decreased, the RT initially increased and then decreased.

CONCLUSIONS

- There is a complicated relationship between speech perception performance and RT (i.e., listening effort)
- The dual-task paradigm is most sensitive when:
  1. SNRs are between +1 and +3 dB (re: SNR50), or
  2. Sentence recognition scores are between 65 and 80 percent correct (Table 1).

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