Measuring speech-in-speech intelligibility with target location uncertainty

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Introduction

A common problem experienced by hearing-impaired people is poor speech intelligibility when in a group of people where talkers of interest frequently take turns and where other people are talking simultaneously.

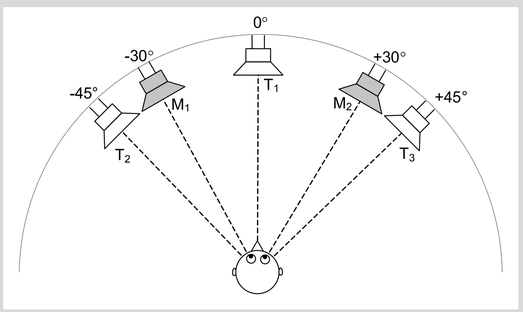
This problem is not reflected in the most common standardized speech-intelligibility tests, which typically are based on presentation of speech from a fixed position in front of the listener in a background of steady-state noise. The result in this type of test is often a speech reception threshold (SRT), which is unrealistically low.

Previous research has shown that the introduction of target location uncertainty (Singh et al., 2008) and speech masking (e.g., Francart et al., 2011) affects performance in such tests in the direction of a higher and more realistic SRT.

A modified version of the Danish Dantale II (matrix) test (Wagener et al., 2003) has been developed, including target location uncertainty as well as speech masking. The first goal was to increase the ecological validity of the test by increasing the resemblance to everyday life (including an increase in SRT). The second (and ultimate) goal was to be able to reveal effects of hearing-aid processing schemes, which cannot be detected in the original test. Only the first goal is investigated in the present poster.

Method

EXPERIMENTAL CONDITIONS



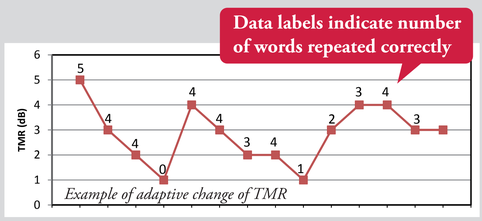
- Set-up in anechoic chamber
- Four different test conditions (see below)
- Target: Dantale II (matrix) sentences, e.g., 'Michael had ten yellow houses'
- Three different maskers (see below)
- Maskers presented continuously (no gating)
- Listener task: To repeat target sentences
- Listener was allowed to turn the head

Condition	Target	Maskers
FT_StatNoi	Fixed at 0° (T_1)	Unmodulated speech-shaped noise at ±30° (M_1/M_2) (Dantale II noise)
FT_ICRA4	Fixed at 0° (T_1)	Modulated speech-shaped noise at ±30° (M_1/M_2) (ICRA CD track 4, single-talker, spectrally shaped as target signal, temporal gaps reduced to max. 60 ms)
FT_2Female	Fixed at 0° (T_1)	Running speech at ±30° (M_1/M_2) (Excerpts from fairytale, two different female speakers, spectrally shaped as target signal, temporal gaps reduced to max. 60 ms)
RT_2Female	Random at 0° (T_1) or ±45° (T_2/T_3)	Running speech at ±30° (M_1/M_2) (As above)

- The order of the three fixed-target (FT) conditions was balanced across participants. The random-target (RT) condition was always the last test condition.
- Each FT condition included 30 sentences. The RT condition included 90 sentences presented randomly from one of three directions (30 sentences from each direction).
- All participants had been trained in all test conditions at a previous visit. In the test session, a training round (consisting of 30 sentences in the FT_StatNoi condition) was completed before the actual testing.

ADAPTIVE TEST PROCEDURE

- The target speech level was fixed at 65 dB SPL. The masker level was changed adaptively between sentences. The target was 60% (3 out of 5) words corrrect.



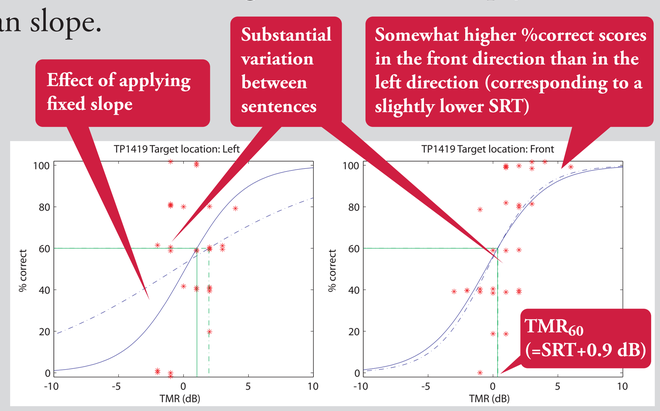
- The start target-to-masker ratio (TMR) in each condition was determined individually based on previous performance.
- In the RT condition, the adaptive procedure was followed disregarding shifts in target direction.

PARTICIPANTS

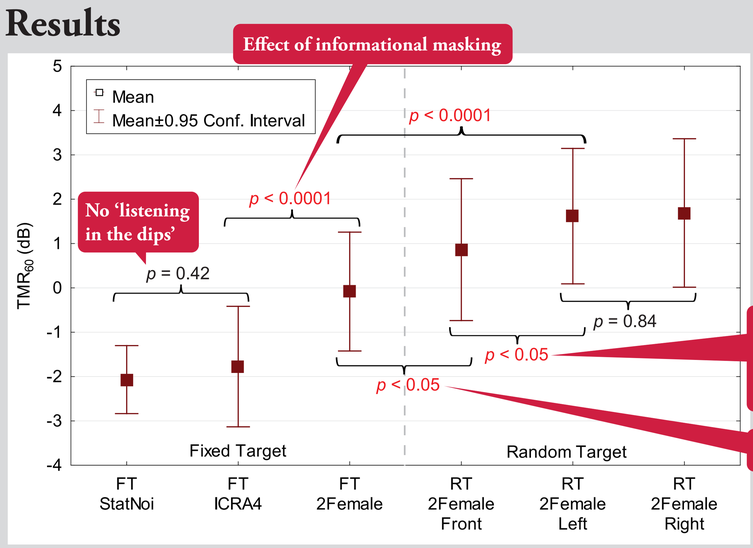
- N = 16 (7 females, 9 males), age: 46-73 years (mean: 66 years), all having previous experience with Dantale II
- Mild-to-moderate, sensorineural, flat to gently sloping hearing losses
- Bilaterally fitted with Oticon Agil miniRITE in prescribed setting, adaptive features turned off during testing

Calculating results

- First, estimating individual psychometric functions for all test conditions (using method described by Brand & Kollmeier, 2002) and calculating median slope across conditions and participants. Second, re-estimating the individual psychometric functions with slopes set to median slope.
- Result determined as the TMR at 60% correct (TMR_{60}).
- All data adjusted for an overall within-session training effect.
- TMR_{60} calculated for each of the three RT directions. The two plots show examples of data from the left and front directions.



Results



A repeated measures ANOVA showed a highly significant effect of test condition ($p < 0.00001$).

Selected results (p-values) from Fisher LSD post-hoc tests, assessing pairwise differences between conditions, are indicated in the figure.

- The lack of benefit of 'listening in the dips' (i.e., no significant difference between TMR_{60} in modulated and unmodulated noise) in this group of listeners is in line with data from other studies, e.g., Festen & Plomp, 1990.
- The exact effect of informational masking depends on the actual choice of target and maskers. The effect observed in the present study seems to be in line with results from previous research (e.g., Francart et al., 2011).
- The effect of introducing target location uncertainty, i.e., the observed increase in TMR_{60}, is in line with the results reported by Singh et al. (2008).
- Many participants expressed that they found the RT speech-masking condition to be much more representative of the situations they face in everyday life than the FT noise-masking conditions.
- Some individual patterns of results deviated significantly from the mean pattern, e.g., in terms of the difference between the front and left/right directions in the RT condition.

Conclusions

- No significant difference was observed between values of TMR_{60} (or SRTs) obtained with unmodulated and modulated noise maskers, respectively.
- Using running speech as masker increased the SRT significantly, thus indicating the effect of informational masking.
- Adding target location uncertainty resulted in a significant increase in SRT of around 1 dB in the front direction.
- The increase in SRT as well as the subjective comments from participants indicate that the goal of increasing the ecological validity of the test by introducing speech masking and target location uncertainty was reached. This suggests further work with the test.
- Estimating SRT for the different target directions in the RT condition may offer ways to differentiate between listeners, which are not offered by the FT conditions.
- More work is needed to assess test sensitivity in the RT conditon. Furthermore, the test could be further developed, e.g., by using other target and masker signals.

References

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