The rate of intelligibility change with level for continuous speech

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1. Introduction

When listening to speech in noisy environments, increasing the level of the speech in comparison to that of the background noise usually increases its intelligibility. A listener may increase the volume on their TV or radio to better hear it, or a talker may raise their voice to be better understood. The amount of perceptual benefit that a listener will actually receive from this improvement in signal-to-noise ratio (SNR), however, is not fixed and instead depends entirely on the slope (gradient) of the psychometric function.

The psychometric function describes the relationship between the relative level of speech and its intelligibility. The shallower the slope of the psychometric function then the less benefit a listener will receive from any gain in speech level that may be offered. We have completed a systematic review of 913 psychometric functions which demonstrated that the median slope for masked speech is 6.4% per dB but that importantly some listening situations give shallower slopes than others. Reduced context, modulations and competing speech, for example, act to flatten the slope.

All the studies identified in the review measured the slope of the psychometric function using short speech tokens: syllables, words, or sentences. Much of the speech we listen to on a daily basis, however, is not presented one word or sentence at a time; instead we are often required to keep up with a flow of information. The aim of the current study was, therefore, to develop a paradigm to measure the slope of psychometric functions for continuous speech.

2. Method

Seventeen listeners (mean age = 68, mean Hearing Loss = 38 dB HL) took part in the study. Participants listened to four-minute long extracts of an audio book over headphones while reading a printed transcript of the same text. Each transcript contained a set number of words which had been intentionally changed and therefore no longer matched those in the audio. The participant’s task was to mark on the transcript any words that did not match those they had heard in the speech. The continuous speech extracts were played in a speech-shaped static noise and performance on the task was measured at seven different SNRs, selected individually for each listener. Psychometric functions were then constructed by calculating the percentages of mismatches correctly identified at each of the seven SNRs.

Seven-point psychometric functions were also measured for each listener using a standard speech-in-noise task. In the standard task, ASL sentences were presented one at a time in a speech-shaped static noise. The listener was asked to repeat each sentence and was given as much time as they needed to respond. Psychometric functions were constructed using the percentage of words correctly identified at each SNR. All psychometric functions were then fitted with a logistic function which was used to derive the slope at 50% correct.

3. Results

The mean slope for the continuous task (3.1% per dB) was found to be significantly shallower than the mean slope for the standard speech-in-noise task (11.0% per dB). This difference in slope is illustrated in Figure 1. The results suggest that listeners may receive considerably less perceptual benefit per decibel improvement in signal level in more realistic listening situations than standard tests would suggest.

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