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HOW DO WE MEASURE SPEECH PERCEPTION ABILITY?

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Abstract

The speech perception ability of hearing impaired subjects is in Sweden measured by means of phonetically balanced lists of monosyllabic words. This procedure has for many years been criticized. In a pilot study, comparison was made between results from 13 subjects tested with the monosyllabic words in quiet (PB quiet), simple sentences presented in noise (BH S/N), and a test consisted of continuous discourse in noise (Subj SN). The correlation coefficient was calculated between the results on the different tests and also from the auditory sub-test of the Hearing Performance Inventory (HPI). A significant correlation was obtained between the results from HPI aud and BH S/N but no correlation was obtained between the results from BH S/N and Subj SN. The result indicates that the two tests measure two different aspects of speech perception ability: the analytic and the global. Experienced handicap might be better correlated with analytic than global speech perception ability.

INTRODUCTION

In the Swedish hearing clinics, the speech discrimination abilities of the patients are first measured by establishing the speech reception threshold (50% level) by means of spondees words, and thereafter the speech discrimination with the use of the Swedish lists of phonetically balanced monosyllabic words presented in quiet. The words are usually presented 35 dB above the speech reception threshold. For a long time, this procedure has been under discussion. Two objections have been raised. Hearing impaired persons mainly complain about the difficulties in understanding speech in a noisy surrounding. The diagnostic value of testing speech discrimination in quiet must, therefore, be questioned. The other objection is the use of monosyllabic words. People do not communicate with single words and, therefore, it must be more relevant to test the speech perception ability of a hearing impaired person by using sentences or, even better, continuous discourse.

In spite of the very long dissatisfaction with the monosyllabic word lists, very little has been done to develop other types of test-material. A noteworthy exception is the sentence-in-noise test by Hagerman (1984). This test consists of five-word sentences. The sentences are of the type: "First name"+"verb"+"number"+"adjective"+"noun". In each position, a stimulus word is randomly selected from a set of 10 prerecorded words. The words are pronounced in a neutral manner which results in a sentence with a relatively natural prosodic pattern. The test-sentences are used to establish the signal-to-noise ratio were 50% of the words are correctly identified. The Hagerman lists are used at some of the Swedish hearing clinics.

In our laboratory, we have made experiments with a test in which the test-material consists of continuous discourse. It is a tape-recording of a speaker reading a short story. In the test, the subjects are first asked to adjust the speech signal to a comfortable level. Noise is then added, and they are asked to adjust the noise to a level where they can just follow the story. The test method gives a subjective acceptable signal-to-noise
In a recent study, the results obtained with this test method were compared with results from the Hagerman test (BH S/N), the phonetically balanced words in quiet (PB quiet) and with the results from a Swedish version of the Hearing Performance Inventory (HPI aud) (Öhngren & Dahlquist, 1989). In the Hearing Performance Inventory, a listening situation is described and the person is asked whether he experiences difficulties in this situation. He selects one of the following alternatives: "Practically always", "Frequently", "About half the time", "Occasionally", "Almost never". The answers are converted into percentage difficulty. The test is divided in several subsets. Here, the results from the subsets that measure the subject’s experienced difficulties in situations without lip-reading is used (HPI aud). In the study, a number of visual and audio-visual tests were also included but here will only some results on the auditory tests be discussed. The small pilot study, which is our first study, is an attempt to develop better tests. In Table I, the correlation coefficients between the results obtained on the different auditory tests are shown.

<table>
<thead>
<tr>
<th></th>
<th>PB quiet</th>
<th>BH S/N</th>
<th>Subj S/N</th>
<th>HPI aud</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB quiet</td>
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<td>-.54</td>
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</tr>
<tr>
<td>BH S/N</td>
<td></td>
<td>-.55</td>
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<td>.23</td>
</tr>
<tr>
<td>Subj S/N</td>
<td></td>
<td></td>
<td>.61</td>
<td></td>
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<tr>
<td>HPI aud</td>
<td></td>
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</tr>
</tbody>
</table>

Table I. Correlation coefficients obtained between the results from the different tests. The number of subjects is 13.

DISCUSSION

Speech perception ability is assumed to depend on two interacting processes: the extraction of information bearing elements in the acoustic signal (signal-dependent information) and the use of knowledge about the language, the situation, the speaker, etc (signal-independent information). It is possible to divide speech tests into two main categories: analytic tests and global tests. An analytic test is primarily based on the patient’s ability to extract information from the acoustic signal. In the analysis, he can use his knowledge of the phonological structure of the language, of word frequency, etc, but does not get any support from the context. Syllable tests and the phonetically balances word lists are analytic tests, and also the Hagerman test, as the number of words are limited and the sentence structure fixed. The use of continuous discourse is an example of a global test and tests consisting of related sentences is another example. In a global test, the subject must also rely on his ability to detect information-bearing elements in the acoustic signal and his knowledge about the language, but he can also use his knowledge about the speaker and the situation. Many tests are a mixture of these two general types.

In our study, the test Subj S/N must be seen as a global test and PB quiet and BH S/N as analytic tests. The Hearing Performance Inventory, HPI aud, is seen as a subjective estimation of the subject’s degree of handicap. Does the degree of experienced handicap correlate with results from analytic or from the global speech tests?

The only significant correlation found (P<.05) is between BH S/N and HPI aud. No correlation was found between BH S/N and Subj S/N which indicates that they measure two different aspects of the speech perception: the analytic and the global speech perception ability. PB quiet shows a moderate and not significant correlation with all
other tests, which seems reasonable, as both analytic and global speech perception ability must be based on the analysis of the acoustic speech signal.

SOME QUESTIONS RAISED BY THE RESULTS
The results of the study raises some question. The test Subj SIN was considered by us, and also by the patients, as a valid test of the everyday ability to understand speech. However, our result does not show any correlation with HPI aud which is supposed to give an estimation of the degree of handicap experienced by the hearing impaired subject. A possible interpretation of this is that experienced handicap is very much the result of the difficulty to identify low-redundancy words (prizes, names, etc). If this is true, this will mean that an analytic test, e.g., lists with phonetically balanced words or the Hagerman test, will give a good estimation of the degree of experienced handicap. However, the test words must be presented together with some kind of noise, and preferably in a sentence context.

The above assumption also has implications for training programs. In auditory and speech-reading training, some programs have been concentrated on the analytic training and other programs on the global training. The results obtained in this small pilot study might speak in favour of an analytic training, but further studies are needed.

References