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Method of correcting the voice pitch level of hard of hearing subjects

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II. SPEECH COMMUNICATION WITH HARD OF HEARING SUBJECTS

A. METHOD OF CORRECTING THE VOICE PITCH LEVEL OF HARD OF HEARING SUBJECTS

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To obtain intelligible and natural speech it is necessary to have correct breathing, phonation and articulation. During learning and in the control of phonation and articulation a normal-hearing child relies mainly on auditory feedback. For persons with hearing disorders the natural way of speech learning is difficult or even impossible. In this latter case external help is necessary.

In order to improve phonation and intonation several types of equipment using visual display of voice fundamental frequency, i.e. voice pitch, have been built and used:

As early as in 1938 Coyne (2, 3, 4, 5) developed a voice pitch indicator using 14-20 band-pass filters and lamps representing frequency. This device has been used in schools for the deaf in South Africa for voice training for some years and with good results. Anyhow, negative results have been reported (3, 4) for pupils of about 14 years or older and with settled voice habits.

"Mandy" (10, 11), a voice training aid built by Plant employs a cathode ray tube as display in which a line moves vertically corresponding to the pitch changes. Informal reports on training with the equipment claim positive results. "Mandy" has been used for voice character training, stabilization of pitch to avoid random fluctuations, and intonation training.

Anderson (1) has reported on a pitch indicator with a rotating cathode ray tube as display. Voiceless sounds are indicated by a light from a separate lamp. Only preliminary test results from use in the schools for the deaf have been published. The main difficulties of the pupils consist in understanding the significance of pitch and what the equipment is indicating.

Dolansky (6, 7) has developed a pitch period indicator for the training of intonation and inflection employing a storage cathode ray tube with a repetitive type of time base. In his experiments the deaf subjects were asked to imitate different simple intonation patterns.
while articulating different stationary vowels. The results show that to some extent deaf pupils are able to learn to control their own pitch and imitate different intonation patterns. But the study does not deal with the problem whether the produced intonation patterns can be learned and used in continuous speech and without the indicator.

Equipment used in this experiment

In the pitch training reported here a somewhat modified version of Tjernlund's (12) pitch extractor has been used. Fig. II-A-1 shows the equipment. A larynx microphone with a PTZ cell is used. The pitch is indicated both on a cathode ray tube, with long persistence screen and a repetitive time base, and on a meter instrument. A pulse train synchronized with the larynx sound can be heard through earphones where the signal can be frequency divided up to four times. This frequency division is intended for the training of severely hard of hearing persons with high pitch level. Fig. II-A-2 shows two typical pictures on the cathode ray tube display. Some preliminary experiments with this device on pitch and rhythm training with children, 10-14 years old, have been made by Olsson (9). The results were promising.

Method of training and results

The scope of this training study was to change the pitch register for two boys of the age of 16. For audiograms see Fig. II-A-3. Both subjects had a very high falsetto voice and the traditional voice training methods had so far failed to change their speech habits. Figs. II-A-4 and Fig. II-A-5 show the distribution of pitch frequency for the subjects measured in a test text containing 14 short sentences.

The mean value of the pitch was:

Subject 1 \( f_o = 277 \text{ c/s} \)
Subject 2 \( f_o = 373 \text{ c/s} \)

The subjects had a daily training of about 10 minutes. After a short explanation both subjects understood the task of the training and could "read" the display.

After 3-4 days subject 1 could phonate a voiced /h/ with very soft onset and "correct" pitch range (about 100-150 c/s). After this first result his progress was fast. He trained one-syllable words with
Fig. II-A-1. Intonation display.

Fig. II-A-2. Voice pitch intonation contours of the word /apelsin/. The display to the right is a sample where the last syllable of the word has been phonated in falsetto.
Fig. II-A.3. Audiograms of subjects I and II.
SUBJECT I

VOICE FUNDAMENTAL FREQUENCY

Fig. II-A-4.
SUBJECT II

BEFORE TRAINING

AFTER TRAINING

VOICE FUNDAMENTAL FREQUENCY

Fig. II-A-5.
initial consonant /h/ and a central vowel as /a/ or /o/. However, to produce a correct pitch and articulating front vowels or moving the articulators at the same time was of some difficulty. But after having practiced different vowel sequences e.g., /eiəeə/ even these difficulties were overcome. After 12 days of training the lowered pitch register of subject 1 was stabilized in his talking both in school and out. His intonation is not correct but he has acquired a normal pitch range and a very pleasant sounding voice.

Subject 2 was able to find a correct pitch register after only some minutes' training. But he had large difficulties with the voice onset after stops even if these occurred in intervocalic position. The voice started in falsetto, and after some 50-100 msec it changed over to the normal register. After about three weeks of training he obtained better control of his voice and even if he made some mistakes (about 5% of the time his voice was in falsetto) he could correct it himself without visual display.

Figs. II.A-4 and II.A-5 also show the distribution of pitch for the subjects after training.

The mean value of the pitch was:

Subject 1  \[ f_0 = 120 \text{ c/s} \]
Subject 2  \[ f_0 = 113 \text{ c/s} \]

An abnormal voice pitch level can influence the intelligibility of speech considerably as shown by the following experiment. A listening test was prepared containing seven sentences spoken before and seven sentences spoken after the training with each subject. These sentences were presented in random order to two groups of six normal hearing listeners. Each sentence was presented only once. The listeners were asked to write down what they heard. The following table gives the number of correctly understood words in percent.

<table>
<thead>
<tr>
<th></th>
<th>before</th>
<th>after training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 1</td>
<td>86 %</td>
<td>88 %</td>
</tr>
<tr>
<td>Subject 2</td>
<td>27 %</td>
<td>49 %</td>
</tr>
</tbody>
</table>

The increasing of intelligibility for subject 2 as a result of the training is really considerable.
Conclusions

Phonation training with the aid of a voice pitch extractor and a visual display has given apparent results in short time for both subjects. The apparatus apparently provides the subjects with efficient feedback information in the form of an exact and detailed information on the voice pitch in real time, i.e. without delay. The subject can easily establish a correlation between the kinesthetic sensation in the larynx and the visual representation of the correct pitch. Once this correlation is established the subject is able to control his pitch by kinesthetic (or auditory) feedback alone without any visual information. The "new" pitch register appears to be very stable for both subjects.

Acknowledgment

The voice pitch training study has been carried out at the Manila School (the school for the deaf in Stockholm) and the results have also been published elsewhere (8).

References

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(4) "The Coyne voice pitch indicator", The Volta Review 40 (1938), No. 8, pp. 437-439 and 468-469.
(10) "Introducing 'Mandy' - A voice training aid", The Teacher of the Deaf 57 (1959), pp. 62-64.