

VISUAL FEEDBACK AND INTONATION LEARNING *

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A significant proportion of foreign language students have perceptual as well as linguistic difficulties in learning intonation. They may not be able to discriminate or identify even large, simple changes in pitch direction. Complex patterns such as the English fall-rise are confused with their direct opposites or with the simple pattern corresponding to the terminal glide of the complex pattern. Such students often have persistent difficulty in imitating from purely auditory models or producing the pattern which they know is required linguistically.

We have found that combined synchronised visual and auditory models are of benefit to these students, provided that the visual stimulus is simple to interpret (see Figure 1) and allows the whole pattern to be stored and displayed; and provided that the student can monitor his own output and benefit from correcting or reinforcing visual feedback, thus establishing appropriate patterns of motor activity (see Figures 2 and 3).

The visual display used is derived by means of the laryngograph developed in the Department of Phonetics at University College London (Fourcin and Abberton 1971 and the references listed there). This laryngograph is based on an electric impedance monitoring technique and responds to vocal fold movement during normal phonation by means of two superficially applied guard-ring electrodes (see Figure 2). The circuit which processes the output from the electrodes is self-compensating for speaker impedance variation and is responsive only to the rapid changes associated with the vibration of the vocal folds during ordinary phonation. The signal obtained from the laryngograph is essentially devoid of supraglottal information and is impervious to extraneous noise both from the speaker and his surroundings. Figure 4 shows laryngograph waveforms, Lx , for normal sustained voicing from a man and a woman. The Lx traces shown are photographed from the display screen of a computer; this is responsible for the dotted presentation.

An instantaneous display of fundamental frequency (Fx) on the screen of a storage oscilloscope is derived by measuring each individual larynx period and

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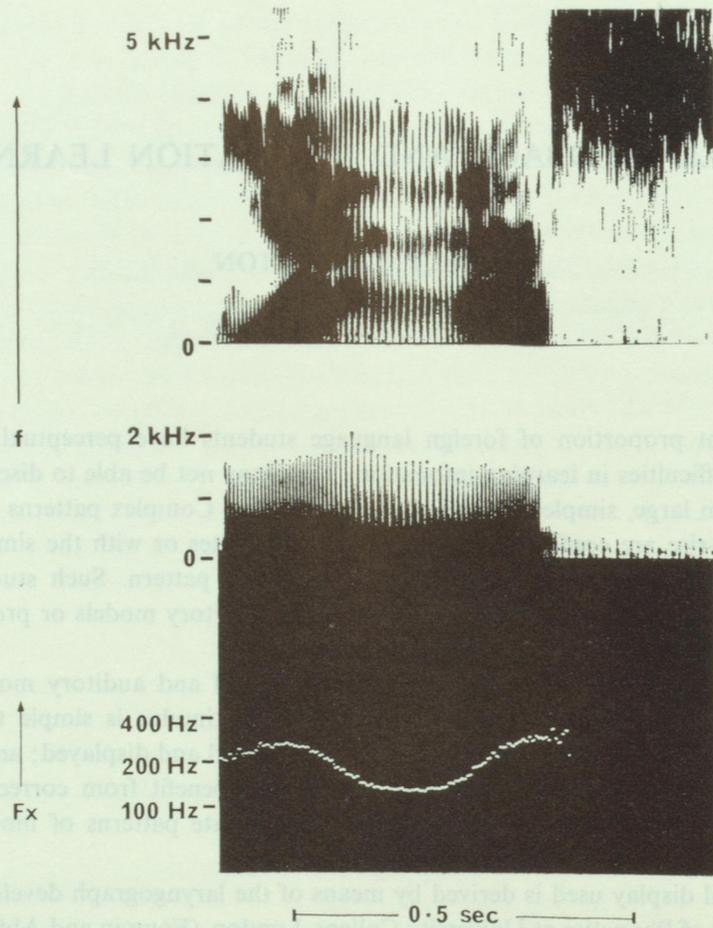


Fig. 1. The top photograph is a spectrogram of the word *Yes* spoken with a falling-rising intonation pattern. The centre photograph shows a spectrogram of the corresponding *Lx*, giving no information about vocal tract resonances or friction; and the lower photograph shows a display of the fundamental frequency derived from the *Lx* of the middle photograph. This simply obtained display, of the type used in teaching, corresponds closely to our perception of intonation.

displaying the negative of its logarithm. This has two distinct advantages: it normalizes pattern proportions for speakers with different pitch ranges, and it shows period by period variation in excitation as well as the overall fundamental frequency contour. Figure 5 shows an *Fx* trace below and part of the corresponding *Lx* above. The *Lx* basic to any given feature can thus be examined in detail, and here the beginning of creaky voice at the end of the fall can be seen.

Displays of the type illustrated have also been successfully used in the speech training of congenitally profoundly deaf adults. *Lx* can be displayed on an oscilloscope screen and used as an indication of the presence of voice, and of register and voice quality, different qualities having distinctive waveforms (see Figure 4).



Fig. 2. A subject practising. She is wearing neck electrodes held in place by an elastic band. The combined laryngograph and fundamental frequency generator are to her left, and on the screen are two *Fx* traces for 'It's easy, isn't it?'

The fundamental frequency display can be used in several ways to improve the acceptability and intelligibility of deaf speech.

1. Simple intonation patterns can be acquired and manipulated. As with foreign learners this ability is retained.

Since fundamental frequency is the primary physical correlate of linguistic stress in English, the important concepts of contrastive stress and nuclear tone can be taught by reference to the display (see Figure 6, which shows the contrastive use of stress by a deaf speaker).

2. The display provides important information about rhythm and tempo which the deaf speaker can utilize by comparing his output with the model trace.

3. Since the laryngograph responds only when the vocal folds are vibrating, information about voiced/voiceless contrasts and the perceptually important variations in the length of preceding vowels, nasals and laterals associated with the distinction can be presented.

The apparatus is simple to use and both hearing and deaf students are enthusiastic about it. *Lx* can be recorded on an ordinary two track tape recorder and used as the

basis of sequences of pre-recorded audio-visual stimuli enabling the student to work by himself, benefiting more than is usually possible in language laboratory work from feedback.

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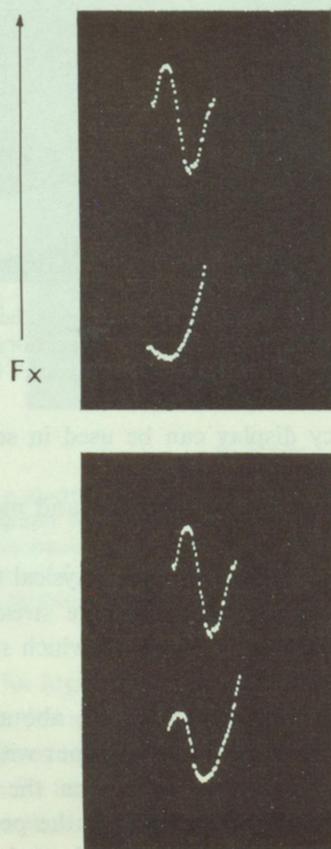


Fig. 3. Two common errors made by French learners of English in the fall-rise: either the rising part goes too high or a simple rise is substituted for the complex model pattern displayed in the upper half of the screen. These errors are often not perceived auditorily by the student, and even when heard are not easily corrected. With the visual display, however, the errors are immediately perceived and quickly corrected.

Direct display
woman man

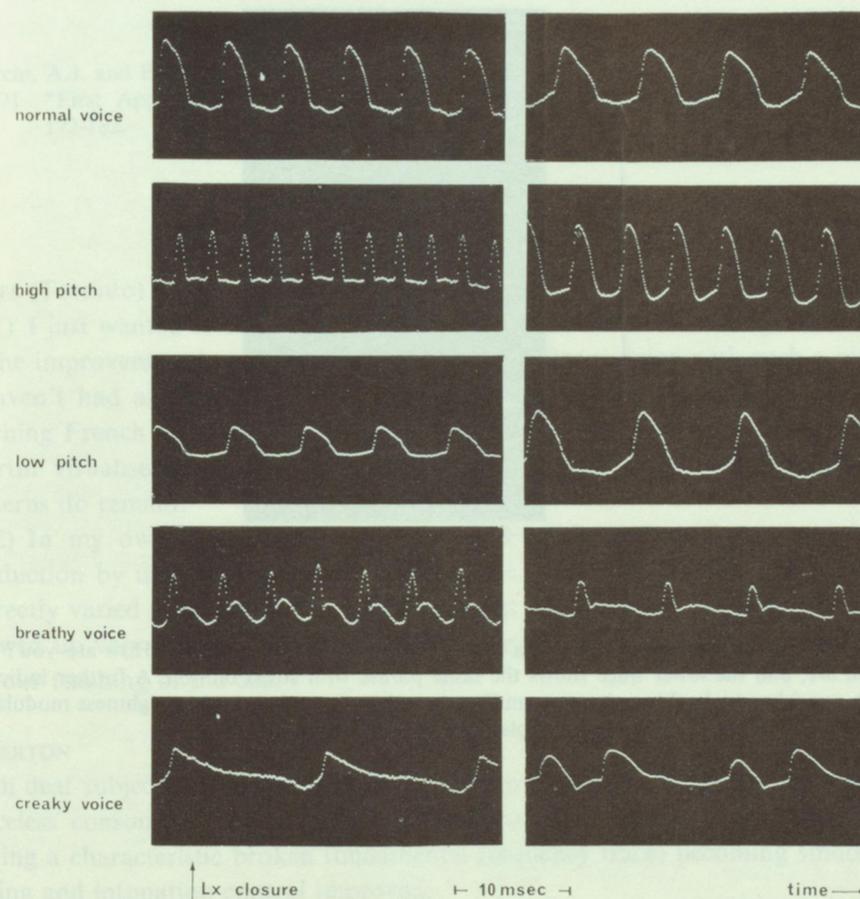


Fig. 4. Laryngograph waveforms, Lx , for normal sustained voicing from a man and a woman.

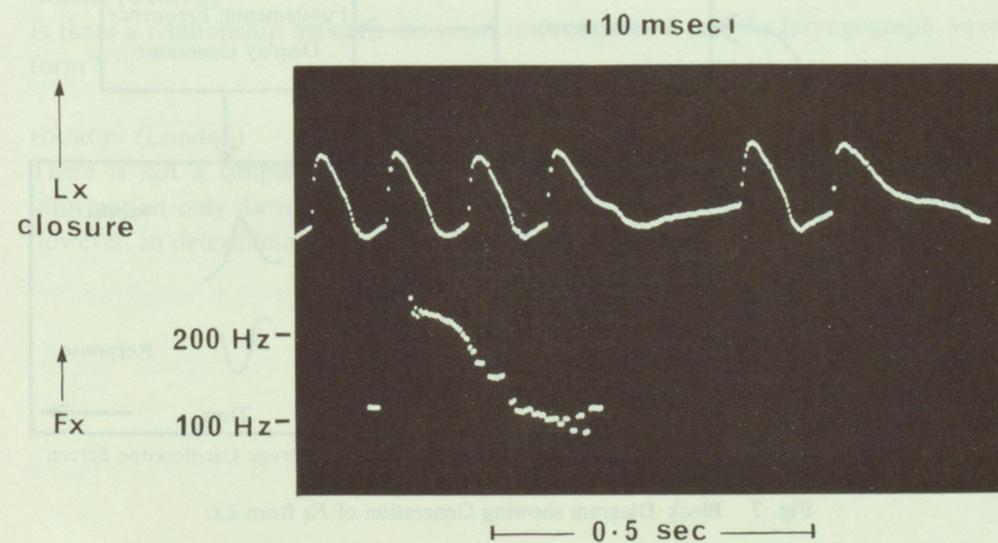


Fig. 5. Fx trace below with the Lx corresponding to the creaky voice at the end of the fall displayed above.

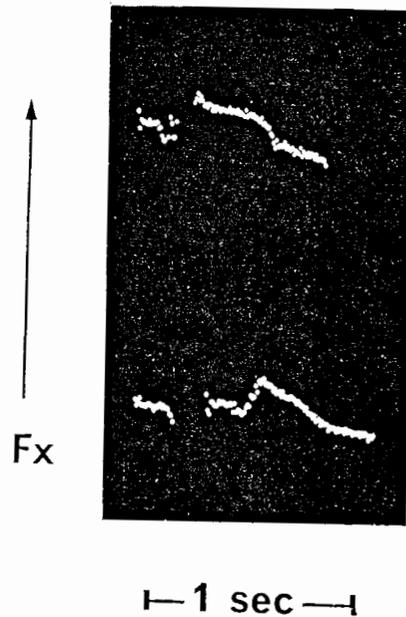


Fig. 6. The use of contrastive stress by a deaf speaker. The top trace shows 'How are you?' with stress on *are*, and the lower trace shows the same phrase with stress on *you*. A further indication of stress could be obtained in quiet surroundings by using a speech intensity brightness modulation. The present display involves only the use of Lx .

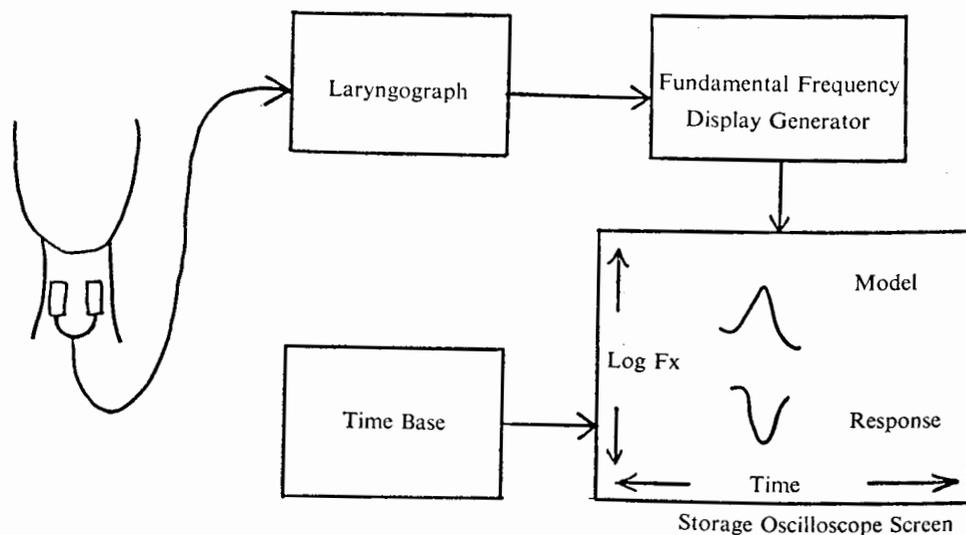


Fig. 7 Block Diagram showing Generation of Fx from Lx .

REFERENCE

- Fourcin, A.J. and E. Abberton
1971 "First Applications of a New Laryngograph", *Medical and Biological Illustration* 21: 172-182.

DISCUSSION

JAMES (Toronto)

(1) I just wanted to support Miss Abberton's statement concerning the durability of the improvement in production of intonation after training with such a machine. I haven't had any experience with teaching the deaf, but in my experiments with teaching French intonation and stress to English-speaking students using the Léon-Martin visualiser, I found that after an extended period of training the correct patterns do remain.

(2) In my own experiments I found that English students improved phoneme production by using the visualiser, for example, voiced consonants which were not correctly varied either from not being varied at all or from a late onset of voicing, showed up very clearly. Did you find the same sort of improvement in articulation in your teaching of the deaf?

ABBERTON

With deaf subjects I have found a similar improvement in the control of voiced and voiceless consonants. Voice quality also improved markedly, a very creaky voice (giving a characteristic broken fundamental frequency trace) becoming smoother as timing and intonation control improved.

MORRIS (Ottawa)

Is there a relationship between the vocal tract excitation and the laryngograph waveform?

FOURCIN (London)

There is not a simple relationship since the laryngograph output contains useful information only during the closed phase. The closed to open phase ratio is useful, however, in determining some aspects of glottal excitation.