Ann. Bull. RILP, No. 15, 165 - 171 (1981)

CLINICAL EVALUATION OF VOICE DISORDERS*

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In the clinical evaluation of voice disorders, various approaches are taken according to the process of voice production. Table 1 summarizes the items selected by the special committee for evaluation of voice disorders of the Japan Society of Logopedics and Phoniatrics. The purpose of the committee is to establish a guideline for the clinical examination of voice disorders.

1. Neurophysiological examination
   Clinical EMG of the larynx
2. Aerodynamic examination
   Air flow rate during phonation
3. Examination of vocal fold vibration
   Laryngeal stroboscopy
4. Acoustic analysis of pathological voice
   Sound spectrographic analysis
5. Auditory evaluation of pathological voice quality
   Labeling and grading of pathologic voice quality
6. Examination of capacity of phonation
   Pitch range, intensity and maximum duration of phonation

Table 1: Approaches to the clinical evaluation of voice disorders

The committee has worked on each item and proposed a guideline for the actual procedure of each examination.[1] In this paper, we will report on these guidelines concerning the auditory evaluation and the sound spectrographic analysis of pathologic voice quality.

Auditory Evaluation

We use five terms or labels which represent five different

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* Text of the oral presentation at 18th IALP Congress, Washington D.C., August, 1980. The work was supported by a Grant-in-Aid for Cooperative Research (No. 337040), the Japanese Ministry of Education, Science and Culture.

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characters of pathologic voice quality: G (grade), R (rough), B (breathy), A (asthenic) and S (strained).

Among these labels, "G" does not actually represent the quality of voice, but indicates the quantity, the general degree of impairment. The term "R" indicates the voice quality related to the irregular glottal pulses. The term "B" indicates the voice quality related to the turbulent noise generated at the glottis, or excessive air leakage through the glottis. "A" indicates the voice quality which contribute to the auditory impression of weakness or powerlessness, and "S" represents strained voice, which sounds as if there is excessive effort or tension in the larynx and also probably in the respiratory system.

These terms are rather common to clinicians working with voice disorders. It should be noted that these labels are not determined by psychoacoustic factor analysis such as the semantic differential technique by Osgood.[2] It is known that the semantic differential technique can extract several factors which represent different features of voice quality.[2] However, recent studies have revealed that some of those factors are related to some general features of voice, such as loudness and pitch, but not to different characteristics within the pathologic voice quality.[3]

In this paper, we will not go into further discussion in this respect. The labels presented here are, as mentioned above, rather common to voice clinicians and easy to understand as to what kind of pathologic voice quality should be matched to each of the labels. The work of our committee is now to prepare appropriate voice samples which are useful as references in matching each label to the specific character of pathologic voice quality.

For each item, evaluation is made on a scale consisting of 0, 1, 2 and 3. Zero indicates the absence of that item, and three the presence of the characteristic in high degree. Thus, a pathologic voice labeled G(3), R(3), B(0), A(0) and S(0), for example, indicates that the voice quality is highly impaired with high degree of roughness but with no breathiness, asthenicity nor strain.

Usually, pathologic voices show more than one feature, and there are various combinations of features in varying degrees. High degree of breathiness is often combined with asthenicity. In order to stabilize the auditory evaluation, a certain amount of ear training using typical reference voice samples is required.

Sound Spectrographic Analysis

The voice samples are sustained vowels. In this paper, the sustained vowel /e/ is taken as examples. In order to examine various acoustic parameters, we use three modes of display as follows:

1) The display of frequency vs amplitude vs time is a pattern display with narrow and wide band filters. The display provides information concerning the perturbation of voice fundamental frequency, F_0, and a general idea of formant pattern and noise to signal ratio.
2) Amplitude vs freqeuncy display is a section pattern of the spectrogram which provides information on the distribution of the sound energy in the frequency domain. We usually use the narrow-band filter which provides some quantitative information concerning the noise to signal ratio of voice.
3) Amplitude vs time display is the amplitude display which represents the fluctuation in amplitude of voice.

Figure 1 shows, from left to right, the wide-band pattern, the narrow-band pattern and narrow-band section of the vowel /e/ in the normal voice. Amplitude display is also shown at the upper left corner of the figure. In the wide-band pattern, we see a regular alignment of vertical striations corresponding to glottal pulses, with little noise in between. In the narrow band pattern, we see harmonic components of voice showing little frequency fluctuation and little noise component. In normal voice, the frequency perturbation in the steady portion of sustained vowel is reported to be within the range of 6% of F_0.[1)]

In the narrow-band section, we can measure the level of the noise component relative to the harmonic component of voice in various frequency ranges. We can also measure the amplitude of higher frequency range relative to that of lower frequency range.

Amplitude display shows a smooth and steady line in the normal voice. The level of fluctuation in the steady portion is reported to be within 3 dB.[1)]

Sound spectrograms of four different types of pathologic vo voice are shown in Fig. 2. In the left side of the figure, we see that the voice quality labeled as "R" (rough) is characterized by the random fluctuation of the glottal pulse resulting in the existence of noise for over-all frequency range. There is also a marked fluctuation in the amplitude display.

In the upper right corner of the figure, breathiness appears to be characterized by a turbulent noise which covers middle to high frequency ranges. Harmonic component in the lower frequency range is kept unaffected. Amplitude display shows a rather smooth pattern. At the onset of voice, there is a turbulent noise before the initiation of glottal pulse. This kind of "intermittent aphonia" is often observed at the onset and offset of voicing in breathy voice during speech.

The voice sample in the lower right corner shows a pattern of asthenicity rather than breathiness. We see a marked decrease of higher frequency component, the relative noise level being fairly low.

At the top of Fig. 3, a continuous utterance of five vowels in asthenic voice is presented. It is noted that in addition to the loss of higher frequency components, this particular voice quality appears to be reinforced by a pitch decline toward the end of voicing.

In the middle and bottom of Fig. 3, there are strained voices. It is difficult to point out a specific acoustic feature which characterizes the strained voice. Among other features, the strained voice shows some increase in the higher frequency component, contrary to the case in asthenic voice quality.

References

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Acknowledgment

This work was supported in part by a Grant-in-Aid for Cooperative Research (No. 337040), the Japanese Ministry of Education, Science and Culture.

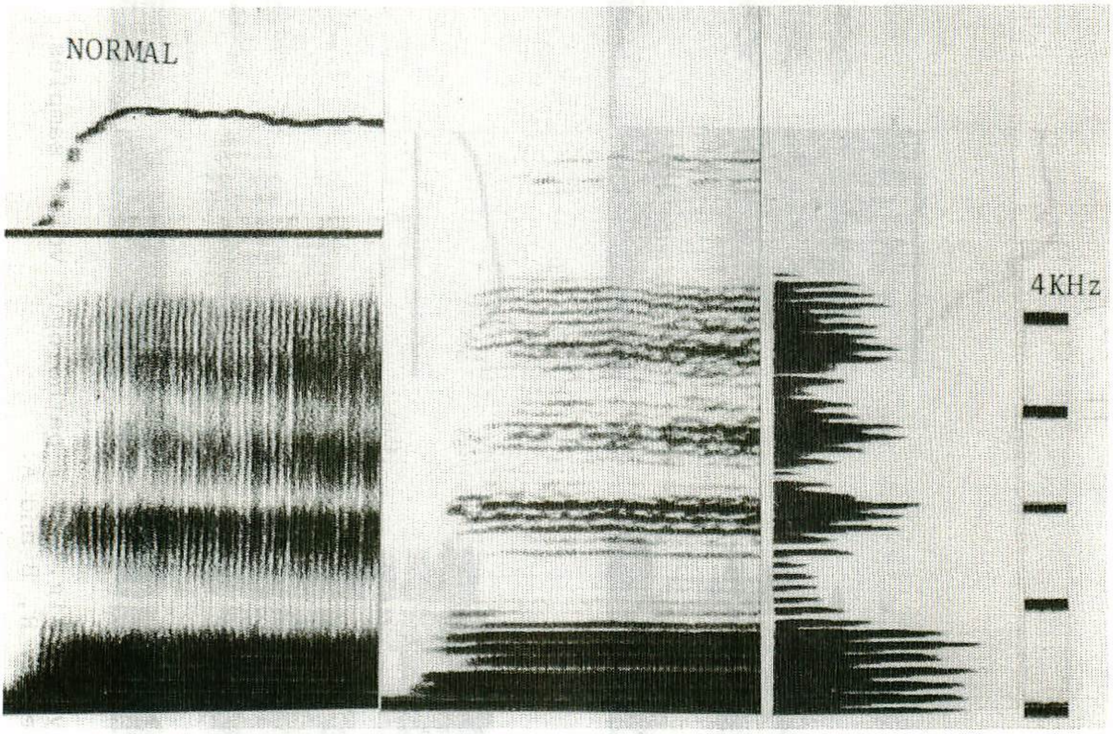

Fig. 1 Sound spectrographic displays of sustained Japanese vowel /e/ in normal voice.

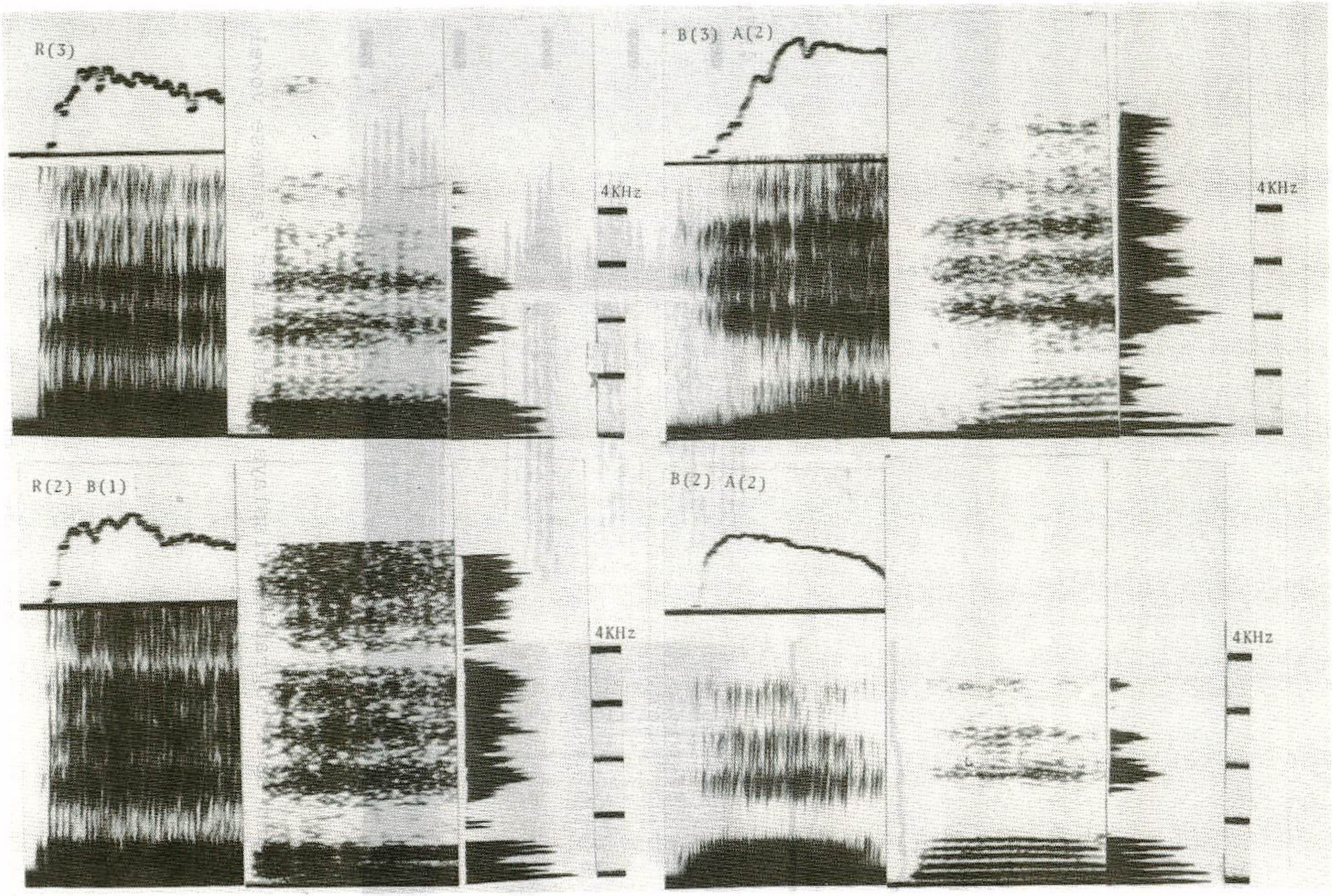

Fig. 2 Same displays as Fig. 1 for pathologic voice samples characterized by R, B and A.

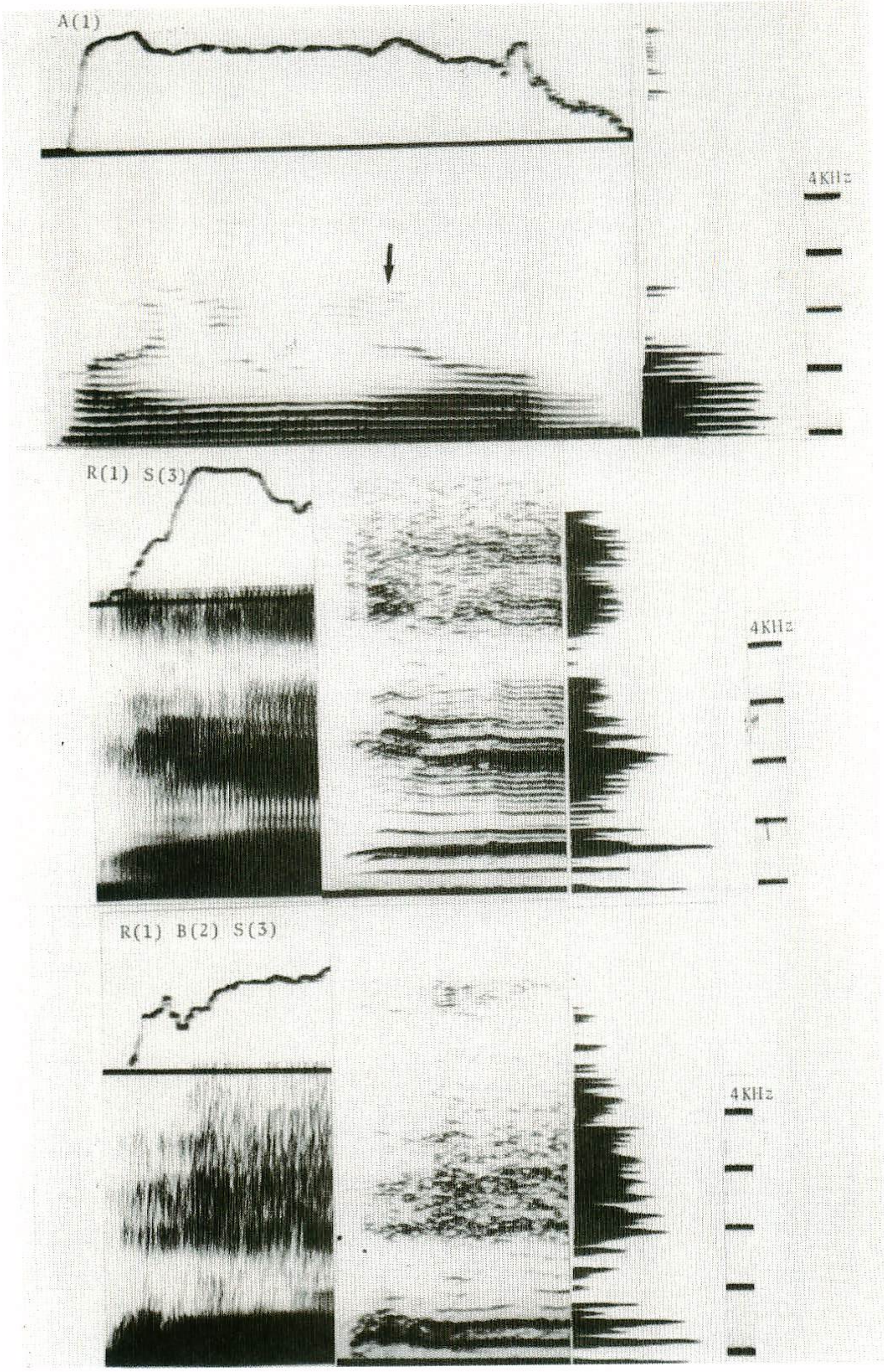

Fig. 3 Sound spectrograms of a continuous utterance of the five Japanese vowels in asthenic voice, and sustained /e/ in strained voice with some other characteristics.