SOME OBSERVATION ON "VOICING AREA" IN VOCALIZATION PHENOMENA

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Introduction

Now that we are engaged in studying the human voice as an object of transmission process in communication, we are forced to meet so many kinds of difficult problems. For instance, in the study of timbre structure of voice and vowel, the most difficult problem is to find the appropriate method of keeping a level of vocalization constant. For, timbre structure is very often effected by the breath intensity of vocalization. On the other hand, it appears that the control of the vocalizing intensity is left entirely to subjects, on whose experiences and intuitions we rely exclusively. If we begin to make research in the timbre- or loudness-study of voices as an object of signal, the first work that we have to do is obtaining the data on the side of vocalizing subject, for "voice" is the object which is represented and manifested by the human being. We have no appropriate measuring method, or suitable apparatus to measure directly the vocalizing intensity. All that we can do for the time being is to measure the output of the voice by VU meter. However, it seems to be important for us that at the biginning we try to reduce the problem of obtaining the vocalizing intensity to the observation of the vocalizing phenomenon, paying attention to the two elements, vocalizing pitch and vocalizing level. Starting therefrom, we proceed to determine a sort of threshold-value in vocalization phenomena. We shall call this "voicing area" or "vocalization loop." Thus we began our experiments by seeking the data on the voicing area about 42 subjects.

Experimental procedure

The subject stands with his lips approximately 50 cm apart from a microphone. He is required to vocalize with the softest tone successively from the lowest pitch to the highest pitch, as long as he can vocalize. The voices received by a microphone are amplified by a amplifier of C-R connection type, and its relative intensity is indicated by VU meter connected to the output terminal of the amplifier. Then the subject is to be vocalized with the loudest tone from the lowest pitch to the highest pitch he can. These readings of VU meter are plotted on the two dimensional coordinates of pitch and level. Diatonic scale is taken as the scale of pitch. The microphone used is of the moving-coil type, and its frequency-response characteristic extends from 100 to 7,500 c.p.s., and its sensitivity-value is of -75 ± 5 db. The frequency characteristic of the amplifier extends from 80 to 8,000 c.p.s., and its sensitivity-value is of 80 ± 2 db.

Choice of subject

Students in the Department of Music of the Aichi Art and Liberal College were selected as subjects, of whom 21 are males and 21 are females. Observations were done with them. Their ages were between 18 and 22. The vowel requested to vocalize is the sustained vowel "A," and, in some occasions, 5 vowels are used.

Results obtained

A part of our data is presented in the diagrams from Fig. 1 to Fig. 9 inclusive. We shall explain them one by one.

Fig. 1 : this is a voicing area taken about the male subject, M. K., aged 20, of Baritone. Vocalized vowel is the sustained vowel "A." The result is represented in the decibel scale for the relative intesity of vocalized vowel and in the diatonic scale for the pitch. The upper curve shows the change of intensity for the loudest vocalization, and the lower curve shows the change for the softest vocalization. The two curves therein, have the same value at E, as it happens in so many cases. Fig. 2 shows a similar sample of the data for female subject C. M. In Fig. 3, we can see a voicing area when the male subject, H. H. aged 18, of Baritone, vocalizes the sustained vowel "A" successively. The numbers of the curves in the graph mean the order in the course of vocalization. In the curve 3, the so-called after-effect of the loudest vocalization is found manifestly. That is to say, the vocalizing level seems to rise with the deviating value over the normal fluctuation in lower pitches. In high pitches, however, the after-effect cannot be found. In the curve 4, we can see the lowering of the upper contour which may be due to the fatigue effect. Further, we should like to add that there is an interesting phenomenon, namely, it is but the range of pitches which seems to be used most frequently in the daily conversations. The after-effect cannot be found in this range, with the softest vocalization, and the fatigue effect is found on either side of this range in the loudest vocalization. (We think, it will be interpreted from the viewpoint of vocalization-economy.) Fig. 4 shows also a voicing area, when the male subject R. M., aged 22, of Baritone, vocalizes the 5 fundamental vowels, which are vocalized in the same as before. Relatively speaking, his career in the

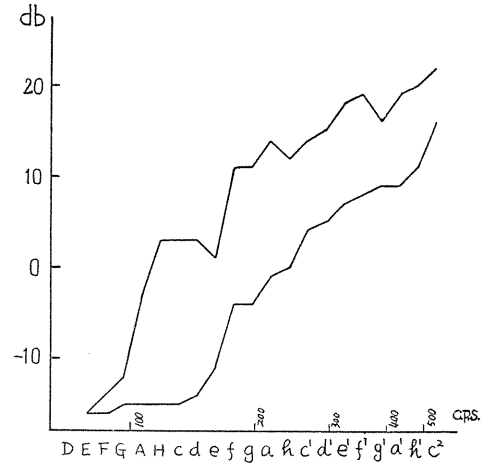


FIG. 1. Sub. M.K., ♂ (20), Baritone, Vowel "A"

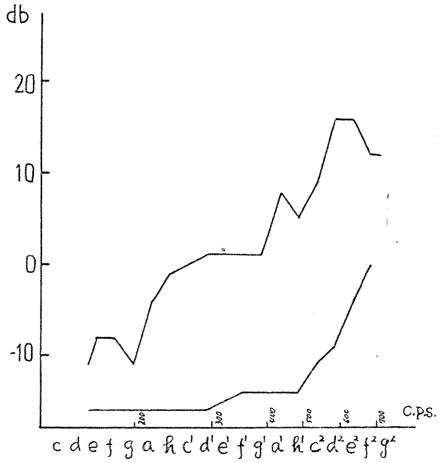


FIG. 2. Sub. C.M., ♀ (19), Alt, Vowel "A"

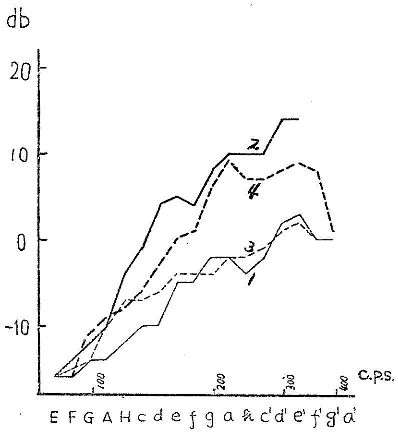


FIG. 3. Sub. H.H., ♂ (18), Baritone, Vowel "A"

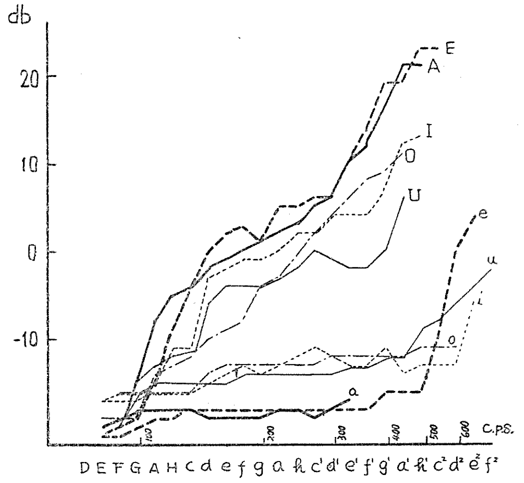


FIG. 4. Sub. R.M., ♂ (22), Baritone, Vowel "A", "E", "I", "O", "U"

vocal training is longer than any others. And his voice is considerably good both in timbre and in loudness. In the graph, we can find an evident character: his voicing range is more wider than any other students who have poorer voices. This is the general tendency observed between good voices and poor ones. The degree of difficulty of utterance, seems to reveal itself as the changes of the voicing range, that is, the shifting of the loudest and softest vocalization curves, namely the width of the so-called dynamic range. Such a condition of affair leads us to the consideration about the difficulties of 5 vowels in singing: judging from the dynamic range, the vowels "A," "E" are easy to vocalize, and the vowels "I," "U" are difficult. From the standpoint of the vowel formation, we are interested in the existence of the upper limit and the lower limit for each vowel. Now we will proceed further to wider observation. Fig. 5: this is a statistical résumé of voicing

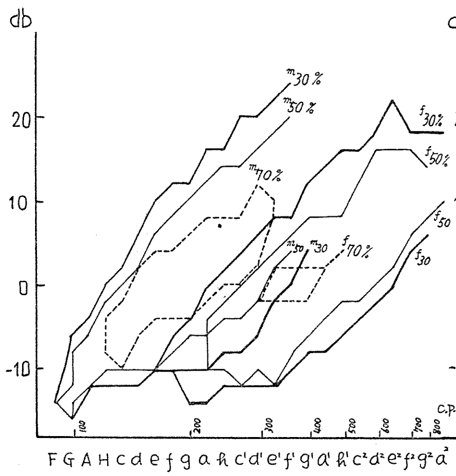


FIG. 5.

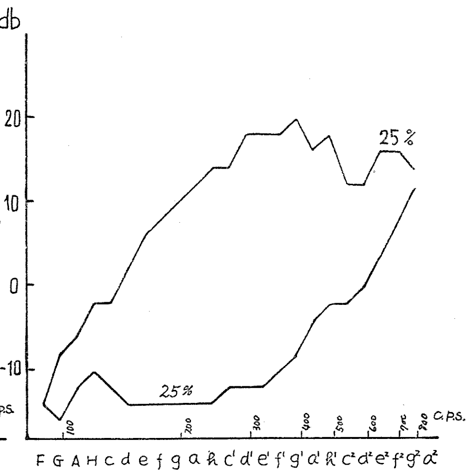
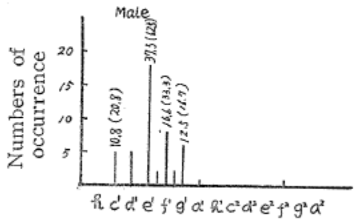


FIG. 6.

area, resulted from the investigation of the voicing range about 24 male cases and 21 females. The left ones are the males' areas and the right ones the females'. And each curve is the equal percentage contour, that is, any level that is thinkable within this loop might have the occurrence that exceeds the assigned percentage. Fig. 6: voicing area is represented in one contour which contains males' and females' voicing area at the same time. In the above experiments, we required the subjects to report their introspection of vocalization by themselves, and in comparing the reports with the data of the voicing range thus measured, we come to notice that the change of the mode of vocalization often effects the curves as the change of the voice intensity. The results are shown in Fig. 7-*a* and 7-*b*. The



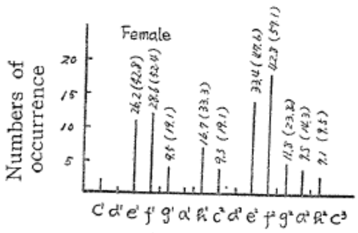


FIG. 7-*a* (*left*). The numbers marked in the graph show the percentage. For instance, the number of times at which the subjects have the break at e^1 is 18. On the other hand, the total number at which 24 subjects vocalize with softest and loudest tone is 48. Therefore, the percentage in which the break is displayed at e^1 is 37.5. And the subjects who have the break at e^1 either in the loudest or in the softest vocalization are 15 subjects among all subjects. Then, it is 62.5%. The number of the latter case is put in parentheses. The other is treated in the same manner.

FIG. 7-*b* (*right*). The numbers in the right graph are the similars with female case.

explanation about numbers therein is described briefly in the graph. As for the quality of vocalization, these discontinuous changes in level and the undesirable unbalances in timbre nuance must be avoided. Therefore, it is necessary to measure the singing area about an experienced vocalist. Fig. 8: in this graph, the singing area of an expert is shown. In comparing it with Fig. 1, it is found that smoothness of the characteristics is conspicuous. Fig. 9-*a* and Fig. 9-*b* indicate how point of the discontinuity is effected by the loudest and softest vocalization. From these graphs, we come to notice that in the softest vocalization the point of discontinuity tends to remove to the lower side by about semi-tone only in the high region for the male, and to the lower side by about semi-tone both in the high and in the low region for the female. This tendency

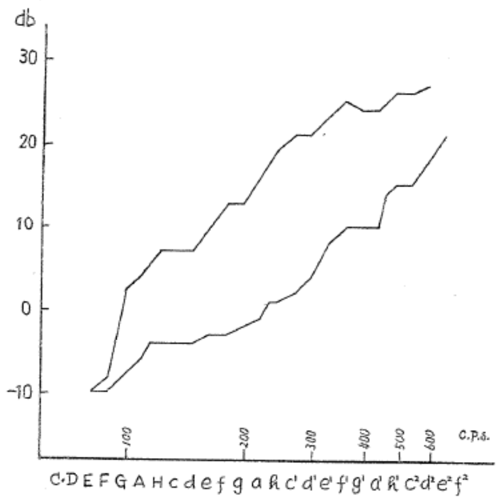


FIG. 8. Sub. S.S., ♂ (35), Tenor, Vowel "A"

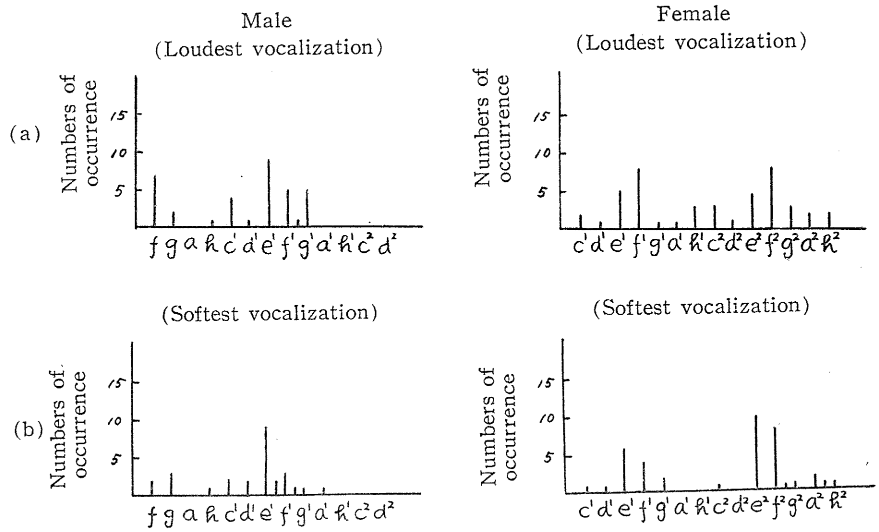


FIG. 9.

can be seen more evidently for the female than for the male. But, we think that it is in need of further study for more solid conclusion.

Conclusion in résumé

1) It seems that the discontinuous point on the curve corresponds to the change of mode of vocalization. It may be considered as the so-called "break" (*Stimmbruch*), but it should be studied still more.

2) It is indicated that the male has the discontinuity point in $e^1 \sim f^1$, and the female has two in $e^1 \sim f^1$ and $e^2 \sim f^2$. This makes a good agreement with the information of experience in singing.

3) If instructions of the vocalization are given as in the vocalization of vocal music, this smoothness of the curve may be taken as a measure of the correctness on the vocalization, or the degree of the proficiency and dexterity on the vocal technique.

4) And, also the magnitude of the dynamic range may become a subject of discussion from the viewpoint of vocal training or the expression ability of the vocal music.

5) Voicing area depends on the kinds of vowels.

6) When we come to think the voicing area as the problem of vocalization technique in vocal music, the voicing area should be treated and detected from the singing viewpoint.

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