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Timbre and Sonance Aspects of the Sustained Vowel "O"

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(5) Perfect fourths tended to center around the two theoretical scale values, which vary from each other so slightly (0.01 tone) as to be insignificantly different.

(6) Analyses of the data suggested that neither (a) durations of tones in the various intervals, nor (b) upward or downward progression of the second tone in a given interval, had any observable systematic effect upon the direction or extent of the played intervals.

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The matter of pitch fluctuation or vibrato in singing has been investigated extensively in the laboratory at the University of Iowa, and it is known that with frequency fluctuation the wave form also undergoes a periodic change. This fact, the so-called timbre vibrato, has not yet been investigated extensively enough to determine whether it is a separate and unrelated factor, or whether it is merely a function of the pitch vibrato.

Rather than stating vowel quality in terms of one wave selected at random from a sung tone, this investigation took into account the matter of the pitch vibrato. The purpose of this study was to make a normative picture of one typical vowel as sung by several singers on different pitch levels and at two or three intensities, and noting the influence of these factors upon the harmonic composition.

After oscillograms had been made of the sung vowel, the frequency, wave by wave, was accurately determined. A number of waves were then selected along the vibrato cycle at approximately equal distances, giving a maximum pitch range for the fundamental of the double amplitude of the vibrato cycle. These waves were then enlarged and analyzed on the Heinrici harmonic analyzer, and the relative intensity of each partial was transferred into decibel values.

As in the customary tone quality spectrum, intensity was plotted against frequency. But in this case, as the fundamental frequencies of the waves selected differed by small increments, it was possible to bring what would be several spectra together and plot them

as one. In this way there was revealed a more or less complete picture of tone quality throughout the vibrato cycle, by the change of the relative intensities of the partials against the frequency change of the total complex tone.

In representing the data, relative intensity in decibels was plotted along the ordinate, and frequency up to four thousand cycles per second along the abscissa. In this way the intensity of the partials gave the appearance of building up upon approaching a resonance region, and diminishing when leaving one. Thus the spectrum was not only indicated, but the formant was, to a certain extent, outlined.

The records studied showed three formants, 450 cycles, 800 cycles, and one above 2000 cycles of rather large extent. These formants, as shown by this study, are not entirely fixed frequency regions, as was generally assumed previously. Shifts of the formant region, especially of the second and third, have been found to be as great as a hundred cycles with an octave increase of the fundamental pitch.

With an increase of intensity, that is, a soft as compared with a loud vowel, the high region of resonance above two thousand cycles generally showed an increase of from five to ten decibels in relation to the total intensity of the sound. The second region also showed a tendency to increase, both with raise in intensity level and raise in frequency level. When these two factors were both operating, the second region often became as important as the first.

A further fact was invariably true throughout the study, that of the decrease of the importance of the fundamental with an increase of the total intensity of the sound. Decrease of importance refers to the relative loss of intensity as compared with the peak intensity of the first formant or as compared with the value representing the total intensity of the sound.

Early investigations along this line tended greatly to oversimplify the matter of vowel quality, and together with this tendency came the danger of too hastily positing physical and consequently physiological reasons for good and bad quality. In view of this, it was deemed advisable to make such a study of one particular vowel in all its aspects, in order that a picture, in the sense of a norm, might be given in terms of harmonic structure, of the essential constituents of the typical vowel.

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