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## Intonation in Violin Performance

Paul C. Greene  
*State University of Iowa*

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## INTONATION IN VIOLIN PERFORMANCE

PAUL C. GREENE

A controversy exists as to whether artists who play stringed instruments perform in the so-called "natural" (sometimes called the "just" or "pure") musical scale, in the "equally tempered" scale, or in some other scale. A related question is whether these artists characteristically enlarge (augment) or contract (diminish) certain intervals as compared with their theoretical scale values.

This discussion is a preliminary report on the problems (1) to what extent violinists approximate either the "natural" or the "equally tempered" scale, and (2) whether they modify certain musical intervals in characteristic ways.

Six professional violinists — all of them reputable artists — thus far have coöperated in the undertaking. Each has played a portion or all of from one to three of the three standard musical selections used in the study. The unaccompanied performances were recorded on moving film by means of an electro-acoustical system including a microphone, amplifiers, and an oscillograph element. Measurements of the fundamental frequencies of the recorded tone were made, and from these data interval extents were computed. The measurements of frequency have been shown to be accurate to 0.01 tone.

In view of (1) the technical limitations of recording and measuring frequency even with a high quality system, and (2) the relatively limited quantity of data at hand, the following interpretations are tentatively advanced:

(1) The recorded artists performed in neither the "natural" nor the "equally tempered" scale. There was a tendency to more nearly approximate tempered than just intonation.

(2) Minor seconds and minor thirds tended to be diminished as compared with the theoretical values for these intervals in either tempered or just intonation. They approximated the tempered more nearly than the natural scale value.

(3) Major thirds tended to be augmented as compared with both just and tempered intonation, and more nearly approximated the tempered value.

(4) Major seconds tended to be very slightly closer to the theoretical value for the "natural" scale, and were very slightly augmented. (It here should be noted that the tonal extent of the interval is only 0.02 of a tone different in the two theoretical scales.)

(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.

DEPARTMENT OF PSYCHOLOGY,  
STATE UNIVERSITY OF IOWA,  
IOWA CITY, IOWA.

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### TIMBRE AND SONANCE ASPECTS OF THE SUSTAINED VOWEL "O."

CURTIS E. TUTHILL

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