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THE NATURAL HISTORY OF THE VIBRATO

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The vibrato has been studied in the psychological laboratory of the University of Iowa from two approaches: (1) phonophotographic recording of musical performance and speech, and (2) psychophysic measurements on the perception of the vibrato produced synthetically by instruments. The following may be regarded as samples of facts that have been established by experiment.*

A general outcome is definition of the phenomenon. An artistic vibrato consists of a periodic oscillation in pitch in which the extent of oscillation for the best singers averages approximately a half-tone and for string instruments approximately a quarter-tone, at an average rate of approximately six or seven cycles per second, and is usually accompanied by synchronous intensity and timbre oscillations which play a secondary rôle.

The following qualitative definition is recommended for musical terminology: A good vibrato in music is a periodic pulsation, generally involving pitch, intensity, and timbre, which produces a pleasing flexibility, mellowness and richness of tone.

The constituent factors being known, a quantitative definition may, of course, be formulated for countless purposes: e.g., the parallel vibrato is one in which the periodic rise of the pitch and the increase in intensity are synchronous and in phase.

The vibrato is present in the voices of all great artists in about 95 per cent of their phonated time, including transition tones, attacks, releases, and rapid passages, as well as sustained tones. The same is approximately true of primitive peoples, such as Indians and Negroes in so far as they sing with great feeling in their native milieu.

It is occasionally found in early childhood and its occurrence increases with age among those who sing with feeling. It is also occasionally present in speech, especially in the sustained vowels of emotional and dramatic speech.

At the present time it is used on sustained tones in nearly all string

instruments. No great violinist of today plays without a vibrato. Occasionally it is also used with wind instruments.

As implied in the definition, the constituent factors are pitch, intensity, and timbre as registered against time determining rate. The final character of a vibrato tone is determined quantitatively in terms of the contribution of each of these variables to the blend in the tone progression. Pitch, intensity, and timbre each vary in extent, rate, and form.

By extent we mean the distance between the top and bottom of the crest, expressed in fractions of a tone. The average extent of the pitch cycle in the singing of artists of today is about six-tenths of a tone, roughly a semi-tone. The same is true of primitive people and adult vocal students but children have a smaller extent.

The average variability in pitch extent for individual singers is quite uniform. Fifty percent of the extents in pitch lie between 0.4 and 0.8 of a tone with a sharp peak between 0.5 and 0.7. The extremes run from 0.1 to 1.0+. The extent of the pitch vibrato in voice does not vary to any marked degree with the actual loudness of the tone, the pitch register, the tone placement, the vowel quality, the sex of the singer, or the musical modes.

The rate of the pitch vibrato, that is, the number of pulsations per second, averages between six and seven cycles. Fifty per cent of the artists' rates fall between six and seven. There is no marked relationship between rate of pitch oscillation and loudness, tone placement, vowel quality, register, sex, or musical mode.

The form of the pitch vibrato approximates that of the sine wave. Minor irregularities and tendencies to distortion occur, but these are probably of but slight musical significance.

Turning to the characteristics of the intensity factor, we find that the average extent of the intensity pulsation in the song of artists is 2.4 decibels. There being about 9 or 10 perceptible differences in the extent of the pitch oscillation, this means that the intensity oscillation is only about one-fourth as perceptible as the pitch oscillation, each taken by itself.

The curve of variability of intensity extents takes about the same form as for pitch extents. The rate of the intensity vibrato is, as a rule, synchronous with the pitch vibrato although not always in phase.

The third variable is timbre. By slowing down a phonograph record one can hear marked changes in timbre of the tone from trough to crest in the vibrato cycle. Harmonic analysis shows these changes to be exceedingly complex so that, although they are conspicuous, it has not yet been possible to formulate any definite rules for the variation in timbre of the tone.

The relation of pitch to intensity presents three basic forms: forty per cent of vibratos are "parallel," that is, the high pitch coincides with the

greater intensity; about 30 per cent are "opposite," that is, there is a reversed relationship; in about 50 per cent, though synchronous, there is a partial shift in phase. The intensity vibrato is present in about 70 per cent of all vocal pitch vibratos.

The most astonishing finding in the whole investigation is the fact that, although the vibrato is almost universally regarded as a medium of differential expression of emotion, measurements show that vocal vibrato does not differentiate to any significant degree between musical modes, between types of emotion, or even between extreme calmness and excitement. This is a shocking finding because the whole practice of the vibrato at the present time rests largely on the assumption that it is a means for differential expression of the feeling of the artist. The cold fact is, however, that the singing vibrato is like an organ stop. You have it in or you have it out and while the performer secures a considerable range of variety in pitch, intensity, timbre, and rate, these are not differentiated. The situation is different in stringed instruments when the player voluntarily changes the vibrato in accordance with what he thinks it should be. Yet even here there is a remarkable uniformity in continuous playing.

Experiments show that it is comparatively easy to develop a vibrato in a child or adult who sings without it, it is possible to administer remedial training both in extent and rate of the different factors, and it is possible to set up artistic goals or norms which may be reached by appropriate training.

As an example of the significance of this, we may say that while the average vibrato of the best singers on the stage today is about a half-tone, experiments tend to show that probably the most pleasing vibrato on the average would be that of the violin, namely, a quarter of a tone or slightly less. If this conception should be recognized, it would be a comparatively easy matter to reduce the vibrato of the best singers of today by about one-half and thereby create a radically new situation for the musical critic, actors and performers.

We do not yet have a complete solution of the physiological explanation of the vibrato. It is clear, however, that physiologically there are several forms of vibrato; that the vibrato is one of the basic neuro-muscular periodicities observable not only in the voice but in various parts of the body, not only in man but also in animals; that in the vibrato there are higher periodicities of two or three orders, riding on the vibrato wave; and that the vibrato is allied to the tremor.

This objective description shows the vibrato to be a gross distortion of tone far greater than is heard in listening to music and it is this underestimation or failure to perceive the vibrato as such which accounts for the tolerance and the utter confusion in regard to the nature and rôle of the

vibrato in the entire history of the subject. It is also an essential condition.

Among the numerous normal illusions which function in the vibrato, four are outstanding. One is the astonishing under-estimation of the magnitude of the vibrato in hearing, which lies in the fact that the oscillation of pitch is heard as if it were only one-fourth to one-half of its actual extent and a similar under-estimation occurs for intensity.

Another normal illusion consists in the persistent confusion of oscillations in pitch and intensity in listening so that a musician, or even a generation of musicians, will assert that it is oscillation in pitch, that it is oscillation in intensity, or, more frequently, that it is neither but some unknown form of pulsation in tone quality.

A third normal illusion, which makes the vibrato in its present gross form tolerable, is the phenomenon of sonance, which lies in the fact that successive periodicities, when of sufficient rate, tend to fuse into a unified tone somewhat in the same manner that the simultaneous overtones in a violin clang fuse and are heard together as one tone.

A fourth normal illusion, which is a condition for making the vibrato tolerable, is the fact that even with a pitch oscillation of a semi-tone the intonation is heard as of a particular tone which can easily be identified with an even or true pitch, the muscial effect heard being that of a changing tone quality. Without these four and numerous similar normal illusions which function in all musical hearing, the vibrato as it now exists would be utterly intolerable.

Thus as in all art, illusion plays a vital rôle in the situation. In this case, the perception of the vibrato as beautiful rests upon one's being subject to these illusions. After all, normal illusions are among the sweetest things in life.

In general, the vibrato in speech is like the vibrato in song in all its characteristics. In their origin, instrumental vibratos are all imitations of vocal vibrato.

In studying the vibrato we have registered song, speech, and instrumental music in such a way as to collect the material for similar treatment of other factors in music and speech from the point of view of deviation from the regular or exact in tonal, dynamic, temporal, or qualitative characteristics of sounds.

I call this the natural history of the vibrato because what we have done is to go out as the botanist does and collect living material for the purpose of classification and experimental studies.

* A full account of these studies appears in "*The Vibrato*," Univ. of Iowa Studies in the Psychology of Music now in press.