

Analytical Study of Vocal Vibrato and Mordent of Indian Popular Singers

Ananya Bonjyotsna and Manabendra Bhuyan, Assam, India

Summary: Objectives. Two very important ornamentations that singers introduce while singing are *vibrato* and *mordent*. Exploring vibrato characteristics of different styles of singing is currently a major interest in musical research. This work presents an analysis of vocal vibrato of Indian pop singers. This paper also reviews a direct relationship between tempo and vibrato, which has been established on Indian pop singers. Another ornament called *mordent* is also widely used by the Indian singers spontaneously. This study performs an analysis of *mordent* and tries to define its characteristics with the help of three proposed parameters: mid-extent, mordent duration and landing note deviation.

Study design. Analytical study.

Methods. A total of 10 Indian pop singers are considered for the study. Reliable vibrato and mordent samples are extracted. The samples are analyzed with the help of *PRAAT*. Vibrato parameters and mordent parameters are computed from the fundamental frequency contour of the samples.

Results. The analysis of vocal vibrato shows that the mean vibrato rate of the singers ranges from 5.26 Hz to 6.66 Hz, and mean vibrato extent ranges from 41.64 cents to 66.79 cents. The study of mordent parameters shows that mordent duration ranged from 0.1 seconds to 0.2 seconds. The mid-extent is found to range from 18 Hz to 38 Hz, and the landing note deviation is found to be 3.62 Hz.

Conclusion. Vibrato of Indian pop singers is analyzed. A relation between tempo and vibrato could be established. A novel method of analysis for mordent has been proposed, which could help in synthesizing this ornament.

Key Words: Vibrato–Tempo–Mordent–Spectral subtraction–Pitch.

INTRODUCTION

The singing voice has been considered the oldest and the most complex of musical instruments in the world. The ability to sing has not only intrigued the singers, but has also attracted the attention of scientific researchers across the globe. The scientific analyses on the singing voice first appeared to have begun on classical singers in the western world. A reasonable amount of research has been done to characterize the singing voice of the trained western classical singers.^{1–6} As research progressed in this domain, the study of singing voices did not remain confined to the western singers alone, but has become more global, with an increasing number of researches being taken up on the singing voice of singers from across the world. One of the important attributes of the singing voice—the production of “vibrato”—is being analyzed extensively by many researchers in the present time. This paper seeks to concentrate mainly on this component of the singing voice—the vibrato—of Indian popular singers and attempts to examine a relationship between vibrato and tempo. The paper will also look into one of the ornaments of the singing voice called the mordent.

Vibrato

Vibrato is one of the most important musical ornaments both in singing and in playing instruments because it produces a

significant effect in tone quality. Vibrato is also important because it is one of the factors on which artistic singing is judged (consciously or without). The study of vibrato itself has undergone metamorphosis since the research carried out by Seashore and his coworkers in 1930s. In 1938, Seashore in his book⁷ defined vibrato as: “A good vibrato is a pulsation of pitch, usually accompanied by synchronous pulsation of loudness and timbre, of such extent and rate as to give a pleasing flexibility, tenderness and richness to the tone.” Vocal vibrato is a desirable feature of singing as it gives richness to a tone. The research interest and the experimental conditions have also changed from broad studies to exploring small facts of vibrato. Vibrato is analyzed mostly in terms of two parameters—vibrato rate (VR) and vibrato extent (VE). Musical instruments including string instruments also exhibit vibrato, and some players display considerable control of vibrato. But singers are said to have no control, or have only limited control, over VR and VE unlike the string instruments.^{7–10} Vibrato has a distinct effect that can help the singers to separate out from the orchestral loud accompaniment¹¹ and make vowels more prominent, allowing them to be more easily heard from background sounds.¹² Sundberg¹¹ explained that the vibrato benefits the singers to fine-tune to the accurate tone in an artistic manner. His experiments also showed that singers singing with vibrato match the pitch accurately, and singing without vibrato causes roughness to the tone. Sundberg in most of his works conducted research with western classical singers. Horii in 1989⁸ investigated the relationships among frequency, amplitude, and phase modulations on vocal vibrato and opined that physically, the vibrato corresponds to a modulation of the fundamental frequency of the voice. Shipp and Izdebski¹³ have established that these modulations typically occur at a rate of 4–7 Hz with a Pitch F_0 modulation extent of ± 1 semitone (100 cents) by carrying out experiments on normal and pathological subjects.

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From the Department of Electronics and Communication Engineering, Tezpur University, Assam, India.

Address correspondence and reprint requests to Ananya Bonjyotsna, Department of Electronics and Communication Engineering, Tezpur University, Assam, India. E-mail address: ananyab@tezu.ernet.in

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Research also proved that good singers establish better and regular vibrato than the nonsingers or untrained singers. Dirk Mürbe et al,¹⁴ has performed a long study and confirmed that trained singers perform better using vibrato effect than nontrained singers. After 3 years of training, the singer who had a VR lower than 5.2 Hz could increase the VR, whereas the singer who had a VR higher than 5.9 Hz could decrease it. Another important aspect of vibrato was indicated in Brown Jr et al¹⁵ concluding that vocal vibrato can be used as a parameter to distinguish trained and untrained singers. This was shown in Brown Jr et al¹⁵ through a study of subjects that suggested that vibrato is one of the factors that can help distinguish between a singer and a nonsinger.

The study of vibrato nowadays is not confined only to western operatic singing, but has extended to other regions of the world and other genres of singing.

A considerable amount of research has been done on vibrato analysis of the singing voice^{14–20} with different classes of songs and geographical regions. Table 1 shows the observations on vibrato analysis in the works^{14–20} for different regional songs.

It has been observed from Table 1 that the mean VR differs for different singing styles. However, the VR is found to range from 5 Hz to 7 Hz in most of the singers except a lowest of 3.5 Hz in classical Chinese operatic songs. Although vibrato parameters of various country singers have been analyzed, the vibrato parameters of Indian singers have not yet been analyzed much. However, research was carried out in Indian classical ornament called *Taan*,²¹ where the rate was found to be 1.65–3.41 Hz. But ornaments like *Taan*, *Trill*, and *Trillo* are significantly different from the vibrato characteristics of the singing voice. Therefore, the ongoing research in vibrato parameters of various styles of singing has motivated us to study other parameters available in Indian pop singing. Analysis of Indian popular singing

has not, to the authors' knowledge, been researched. The purpose of this paper is to study the parameters of 10 Indian popular singers.

Mordent

Mordent, which is a rapid alternation between a note and its successive note of a particular scale, is an important ornament to a piece of song. Singing without this ornament is nearly impossible in the genre of popular songs. But many times, it has been overlooked and does not get due attention. This parameter signifies how capably a singer can sing a note with a single rapid alteration with the note above. Therefore, we have made an attempt to parameterize the mordent in Indian popular songs.

This paper also tries to study this specific ornament called *mordent* (in Western music), also called *Nokku* (in Carnatic music), which means a fast switching between a note and the next higher note once. These notes (*Swaras*), which are touched upon, are often said to be hidden and also called as hidden notes (*Anuswaras*). *Swara* and *Anuswara* are the two Indian words meaning *note* and *hidden note* respectively. Coming to the genre of popular music whether Indian or Western, this particular ornamentation is extensively used while singing and, most importantly, it is often introduced involuntarily. These hidden notes are not articulated voluntarily, and there is no emphasis on them while a song is sung.

This involuntarily spontaneous ornament has motivated us to analyze the underlying parameters of this effect. In this research, three parameters are proposed, which can describe an execution of mordent—mordent duration (DD), mid-extent (ME), and the landing note deviation (LND). The analysis of these three parameters leads to the characterization of mordent.

TABLE 1.
Overview of Prior Works on Vibrato Analysis

Reference No.	Vocal Input/Songs/ Singing Style	No. of Singers	Observations
15	Sing the first stanza of "America the beautiful"	20 Singers (pro) 20 Nonsingers	Presence or absence of vibrato is only observed. Professional singers have prominent vibrato.
16	Suprano singers singing the tone B-flat of the same song	75 Singers from 1900 to 2010 105 tones	VR decreased from around 7 Hz to 5 Hz over the century
17	Classical Pecking opera (Chinese opera)	7 Male (pro)	VR found to be 3.5 Hz
18	Opera, rock, and Brazilian country	5 Singers each style	VR = 5.77 Hz (Opera) VR = 5.04 Hz (Rock) VR = 5.91 Hz (Country)
14	Asked to sing ascending–descending three-tone triads pattern on vowel [a], once before and after 3 years training in singing	22 Singing students	After training, VR slower than 5.2 Hz became faster and VR faster than 5.8 Hz slowed down.
19,20	Western classical singers sang "Ave Maria"	10 Singers 25 Tones	Mean VR = 6 Hz Mean VE = 71cents

Abbreviation: Pro, professional.

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