AN EMPIRICAL STUDY OF INTONATION IN RAGA KALYANI

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ABSTRACT

Theories of intonation in Carnatic music have traditionally been approached within the context of the system of 22 sruti-s. These theories were seldom verified empirically. This paper tries to give a glimpse of the variability in intonation with the help of Kalyani, a well-known Carnatic raga. Current research on pitch analysis by this author revealed that intonation in general in the performance of Carnatic raga-s varies significantly.

INTRODUCTION

It has been of interest to the musicologist to determine the musical pitches in an octave. Right from the ancient treatises on Indian music through the medieval times to the modern era, this subject has remained a prominent one. But, the deliberations were mostly theoretical in nature. With the advent of computer tools which can be effectively used to measure the pitches of musical notes, theories of intonation must be verified empirically.

Theories of intonation so far have not taken into consideration the perception aspects of music. A study of intonation purely on acoustical basis does not give the true picture. Psycho-physiological perception process and psycho-acoustical pitch measurements will throw more light on the matter of intonation which is subjective. Only a holistic approach will enable a full understanding of intonation.

EARLIER STUDIES

C.S. Ayyar [1] was among the earliest to have measured musical pitches. Very few people have conducted empirical studies using a computer in the recent past. Krishnaswamy [2] and Subramanian [6] have contributed to this nascent field concerning Carnatic music. Other scholars for the Hindustani idiom have already done significant work in this area. But due to the complex nature of this topic, a lot more concerted work is required to be done before a realistic and a comprehensive model of intonation can be developed. Such an understanding has important practical applications.

METHODOLOGY

Measurement of musical pitches can be done on a computer using various pitch analysis softwares. The software used for the purpose of this study is called *praat*. Details are available at http://www.praat.org/. This software uses autocorrelation method to determine the pitch.

Raga Kalyani rendered by violinist, V.L. Sudarsan (VLS), was privately recorded using a minidisk recorder and the audio sample was ported to the computer for the analysis. In addition to this private recording, several other renderings of this raga, sourced from commercially available pre-recorded CDs/cassettes, were also analyzed as listed below.

Isolating a musical pitch from a rendering and determining a unitary pitch value is extremely difficult. Even if such unitary values are obtained, there will be several measurements if one does not average them out. This paper provides such distinct pitch values without averaging to highlight variability in intonation. Pitch values that are more than 10 cents apart are counted as distinct. More importantly, instead of unitary pitch values, characteristic pitch movements are graphically captured in pitch plots and presented in this paper. Such movements are generically called as gamaka-s. But it must be realized that many gamaka-s used in Carnatic music are not mere embellishments; as they are integral to the overall raga gestalt.

RAGA KALYANI

This major Carnatic raga employs all ‘white’ notes except Ma. This raga has been specifically chosen for this study because of this very fact. The white notes are supposed to be closer to the theoretical values as they find sympathy in the natural harmonics of the accompanying tambura. This study investigates this supposed relationship. But, Ma is generally believed to be anchored on Pa, with a value of 45/32 or 590 cents [5]. The same author gives the value of Dha as 27/16 or 906 cents. Ni of Kalyani is supposed to be higher than normal, with a value of 243/128 or 1110 cents [4]. As for the other svara-s, the generally accepted value of Ri is 9/8 or 204 cents and the two likely values of Ga are 5/4 or 386 cents and 81/64 or 408 cents.

In addition to the private recording by violinist V.L. Sudarsan, four other renditions of Kalyani are taken for this pitch analysis. 1. Mandolin U. Srinivas (source: Janaki Ramana - RPG CDNF 157048). 2. M.L. Vasanthakumari (souce: M. L. Vasanthakumari - Gita GCD 503). 3. M. Balamuralikrishna (source: cassette Kalyani - RPG (HMV) STHVS 868355). 4. Maharajapuram Viswanatha Iyer (source: Maharajapuram Viswanatha Iyer - RPG CDNF 147914). These artists will be referred to in this paper by the following short names in the same order as above: VLS, USR, MLV, MBK and MVI.

INTONATION IN PERFORMANCE

Intonation is the manner in which musical notes are pitched in the performance of music. Intonation in performance is known to be variable. With the characteristic gamaka-s and phrases in Carnatic music, it is a common understanding among musicians that the plain and fixed values assigned by musicologists to svara-s do not apply in actual performance. But it is generally believed that the theoretical values are valid references. In other words, the deviations in practice are accounted from these references which are considered ideal. Empirical pitch measurements presented in this paper

and elsewhere [2, 6] reveal that even as single values, the measured musical pitches do not seem to conform to such theories. Moreover, such single values if found are not fixed. They vary with, within and across renditions.

The fluidity of svara in Carnatic music has been brought to the fore in this paper. It must however be noted here that variability in intonation in practice does not suggest that any pitch is acceptable but there is certainly perceptible latitude. Definite pitch profiles do exist as determined by the requirements of the raga. Pitch Plots given in this paper are illustrative.

Variability of intonation also depends upon several other factors such as timbre, tempo, harmonic content etcetera, in addition to pitch. These factors mutually influence each other. Musical context also affects intonation. But this paper looks primarily at the aspect of pitch only.

EMPIRICAL STUDY

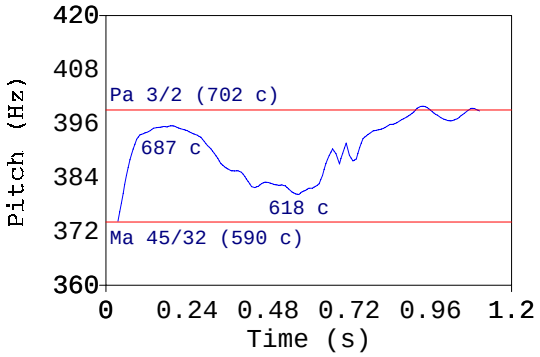
Pitch analysis data of plain notes occurring in the scale of Kalyani played by violinist V.L. Sudarsan is given in Table 1. Mean pitch values in cents along with the maximum and minimum values are also given within brackets.

Table 1: pitches of steady notes in cents

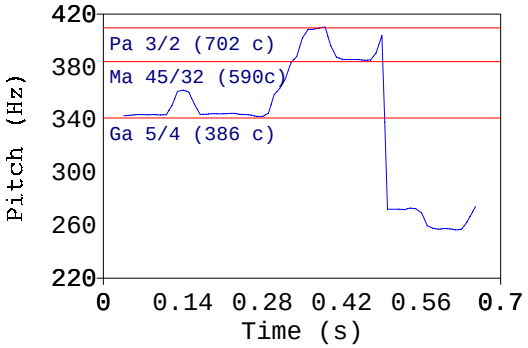
Svara	Ascending	Descending
Ri	215 (217:212)	210 (212:208)
Ga	391 (393:389)	406 (408:402)
Ma	600 (603:598)	597 (600:595)
Dha	913 (916:910)	919 (920:917)
Ni	1108 (1109:1108)	1127 (1128:1125)

Datum Sa = 266 Hz.
Variation in Sa = 12 cents
Variation in Pa = 8 cents
Variation in upper Sa = 12 cents

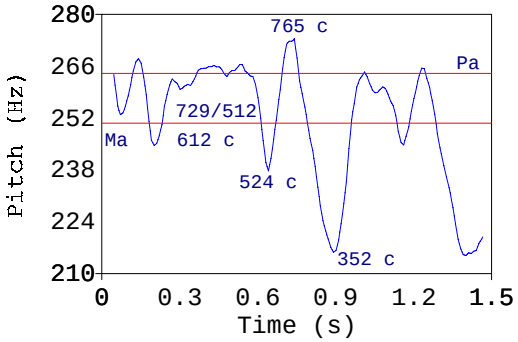
Additionally, several pitch measurements from the other renditions as mentioned above have been taken. The primary focus has been the madhyama. Two distinct values of Ma, 595 cents and 609 cents, have been measured from USR's rendition, as they are more than 10 cents apart. Pitch Plot 2 captures an occurrence of Ma graphically. Ni was measured at 1100 cents. Measuring Dha proved to be very difficult; however one value of 898 cents could be measured. MLV's rendition was based on Ni which ranged from 1104 to 1132 cents and when the Ni was a leading note to Sa, it overshot Sa. Ma measured between 498 cents (Ma) and 702 cents (Pa). Pitch Plot 3 captures one of the Ma-s of MLV. Measurements of Ma from MBK also gave two distinct pitch values: 585 cents and 621 cents. Pitch Plot 4 offers a profile. Ni measured closer to the 15/8 value as opposed to the expected value of 243/128. MBK's Dha measured 880 cents. Likewise, MVI's Ma measured 665 cents & 678 cents.



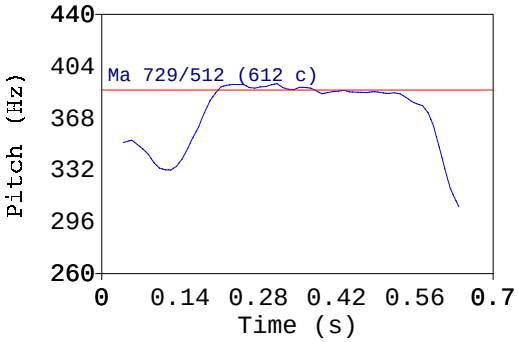
Pitch Plot 1: VLS-Ma [Phrase: **Ma**-Pa--]



Pitch Plot 2: USR-Ma [Phrase: Ga-Ma-Pa-**Ma**-]

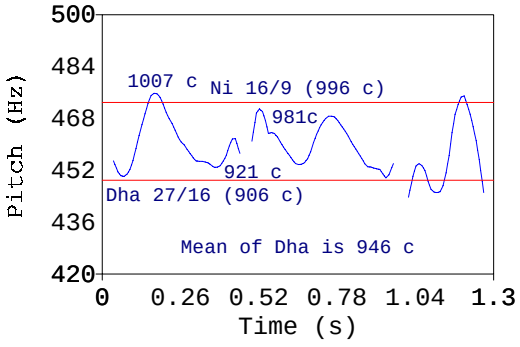


Pitch Plot 3: MLV-Ma [Phrase: Pa—$^{(Ma)}$Ga-**Ma**-Ri]

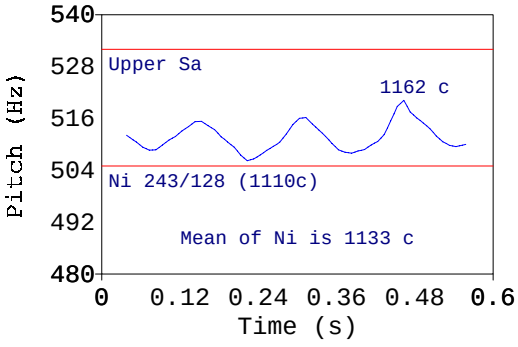


Pitch Plot 4: MBK-Ma [Phrase: Ga-**Ma**--Ri-]

The measured Sa values of these five artists are 266 Hz, 273 Hz, 176 Hz, 135 Hz and 136 Hz respectively in the order as mentioned above. There is variation even in the datum Sa values. The measured variations are 12, 17, 25, 30 and 29 cents respectively in the same order. Greater pitch variations among vocalists are to be expected because of the inherent vocal mechanisms.



Pitch Plot 5: VLS-Dha [Phrase: -Dha-**Dha**-Dha-]



Pitch Plot 6: VLS-Ni [Phrase: Prolonged **Ni**]

Additionally, two more plots depicting Dha and Ni rendered by VLS are also presented in this paper, as shown above in plots 5 & 6. Mean of Dha is 946 cents and that of Ni is 1133 cents, in this case.

From the pitch plots 1 to 4, it is clear that Ma equates neither to 45/32 nor to 729/512 consistently. The acceptable range exceeds the interval between these two values significantly. In fact, it even touches the lower Ma, particularly when Ga is rendered with the characteristic oscillation. The belief that Ma is anchored on Pa and is therefore always higher is also not found to be true. But in such phrases, Ma may be intoned almost on Pa. Similarly, sometimes Ni is intonated almost on Sa, with a value much higher than the expected 1110 cents. And at other times, it is lower than this value.

DISCUSSION

The measured values of pitches employed by raga Kalyani and the characteristic pitch movements as shown above do not match with the fixed pitch values proposed by theorists [4, 5]. The difference between the two varieties of a note has been given as 22 cents. But several times, the measured pitch value either clearly lies in between, or lies significantly above or below these reference values. The fact that the raga characteristic remains intact and is identifiable as such, despite such variability shows that the very idea of individual pitch fixation runs counter to the exigencies of the raga system. It is not the individual pitches that determine a raga, but certain intervals and phrases which operate with latitude and have mutual influence that come together to shape a raga. There seems to be an overall balance. Pitch values of svara-s are not fixed, unitary and static as was thought; instead they vary dynamically but within certain parameters. Exploring these factors is beyond the scope of this limited presentation. But it can be said that mathematical definitions of either the 12 notes or the 22 sruti-s in an octave are not adequate to explain the system of raga music.

Intervals in Carnatic music are melodic and by extension, Intonation in Carnatic music is melodic in nature. Melodic intervals (sequential notes) do not result in beats and therefore do not require mathematical rigidities that are imposed on harmonic intervals (simultaneous notes). Intonation is also characterized by the accompaniment of tambura. However, this is not examined in this paper.

It must also be reiterated that in order to understand fully the subject of intonation, it has be dealt with holistically taking into account physiological, psychological, psycho-acoustical aspects and even cultural and idiomatic idiosyncrasies. Scholars [3] in Carnatic music are beginning to work in this direction as well. A mere acoustical study will not grant a comprehensive insight into the nature of intonation to which the wholesome process of perception is integral.

CONCLUSION

Pitch measurements in Carnatic music, using computer software tools is a very recent field. This paper looks at the intonation in Carnatic music empirically, with the help of raga Kalyani rendered by well known performing artists. It is observed that intonation is variable and does not conform to the fixed intonation theories currently prevailing. It is suggested that the process of intonation is not merely physical but is also psycho-physiological.

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