Comparative Studies on Japanese Traditional Singing and Bel Canto

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ABSTRACT

Compared here is Japanese taditional singing and Bel Canto for Japanese letters. Various genres of Japanese traditional singing are recorded in anechoic chamber for singing and natural voices employing many "living national treasures" as informants. Comparison is made on articulation and temporal features of fundamental frequency. Articulation for vowels is discussed from the points of formant frequency and cepstrum. Deviation of singing utterance from natural utterance within each individual is compared mainly in the formant frequency domain. Temporal features in fundamental frequency are discussed as characteristics of vibrato, particularly its depth and build-up time.

INTRODUCTION

The main purpose of this paper is to point out how to sing Japanese letters by clarifying the differences between acoustic features of Japanese traditional singing and Western Bel Canto. One of the aims of this paper is to put a claim on Japanese education system for music, or singing Japanese letters in particular. In the beginning of Japanese civilization in Meiji era or around 1870, the Japanese Government authoeized European music as music to be tought in schools in Japan though Japan had her own flourish music culture.

Japanese teachers in music were forced to teach the theory of harmony to the people that were accustomed to sing and listen to music that begins and ends with ``Re". They taught Bel canto instead of ``rohkyoku" and ``ko-uta" that were popular in Japanese society at that time. So, Japanese traditional music has come to be taught in private houses of masters (``o-sshosan")

apart from authorized school, and Japanese people has come to think that school music is different thing from their daily music. The situation is now changing somewhat, as Japanese traditional music is treated in textbooks for primary school children. The problem now is that there is few teachers who can teach Japanese traditional music.

The following section briefly explains features of Japanese traditional music, then the paper describes the data employed, and discusses deviation of singing voices from natural voices concerning outstanding performers of Japanese traditional music. The last section compares vibrato in Japanese traditional singing and that in Bel canto.

FEATURES OF JAPANESE TRADITIONAL MUSIC

Japanese traditional music has following features:
a. Genre independency:
    Very few common factors in instrument, voicing, musical scale, rhythm, notation, composer, performer, performing place and so forth. Situation is completely different from that of western music, which usually involves many instruments on common factors.
b. Changes similar to cell division in contrast to evolutional changes in western music:
    New schools come out of old schools and usually coexist emphasizing the difference from the old even if it is small.
c. Respect for timbre or instruments:
    If a music piece is played on different instruments, they are regarded as pieces of different genres.
d. Integrated art:
    Most genres are connected to some other items such as literature, dance, drama playing, religion and local or national events. Then, the integrated arts such as Noh, Bunraku and Kabuki are collectively called ``Geinoh'' (public entertainment) including their music.
e. Weights on singing:
    Most of traditional music is sung music, though there are some exceptions such as shakuhachi-solo and instrumental performance by soh. Division of singing and playing depends on customs of the genre. Songs are roughly divided into ``utai-mono'' (songs for singing) and ``katari-mono'' (narrative songs) according to their features.
f. Features from a viewpoint of Music Theory:
    (i)   Generally monophonic.
    (ii) Complicated rhythmic asynchrony between song and instruments.
    (iii) Pentatonic scales (Folk music scale, Miyakobushi-, Ritsu-, Ryukyu-scales)
    (iv) Relative but not absolute scale except Gagaku (Imperial Court Music).
    (v) Mainly duple meter but not constant rhythm.
    (vi) Frequent use of melisma.
    (vii) Combinatorial use of custom phrases rather than structural composition.
    (viii) Tablature is used rather than staff notation.

DATA OF SINGING AND NATURAL VOICES

The range of informants contributed to our research project covers most genres of Japanese

traditional singing music including TV-news reading and western Bel canto. Singers of Japanese traditional music are, in particular, representative performers of the genres, among them 17 are "living national treasures". Singers were asked to utter in four modes: 1) to sing a common letter "Kaede iroduku yamano asa wa ....", 2) to sing Japanese five vowels in the style of his/her genre, 3) to utter the five Japanese vowels in isolation in natural speaking style and 4) to sing a typical excerpt of the genre. All the recording were made on digital audio tape in anechoic chamber except one called "the last GOZE(blind female street singer)", who has been living in hospital. The data used in the current research is only a part of the data of mode 2) and 3) described above.

ARTICULATION OF VOWELS

Formant Shift

Differences between singing voices and natural voices are compared among genres using formant frequencies of five vowels as characteristic features. Figure 1 compares typical examples of formant shift from natural speech to singing voices for bel canto and Noh. Figure 1 (a) shows formant shifts of the five vowels in singers of western classical singers, while (b) shows those of Noh players. Formant shift appears mainly for F1 of /u/ in bel canto singers, while formant shift of Noh players appears mainly for F1 and F2 of /a/. Figure 2 shows a typical formant pattern of singing /a/ by a Noh player. Formant frequencies in Fig.2 are too low for those of /a/, but are rather close to those of /o/, that coincides with its perceptual impression. Though Noh and Kyogen are played on the same stage, voice quality of these two are quite different as shown in Fig. 3, which compares spectral envelopes of /a/ uttered in Noh and Kyogen. Figure 3 (a) shows that F1 and F2 of /a/ are close to each other situated in the frequency region nearly corresponding to that of /o/, while those of Kyogen are much similar to those of natural speech. Figure 4 plots deviations of the first and second formant frequencies of five singing vowels from natural utterance by 10 bel canto singers, 7 Noh players, 6 Kyogen players and 5 amateurs, where the abscissa and ordinate represent average deviation of the first and second formant frequencies, respectively.

(a) Bel canto (26/12 samples/vowel)   (b) Noh (11/7 samples/vowel)
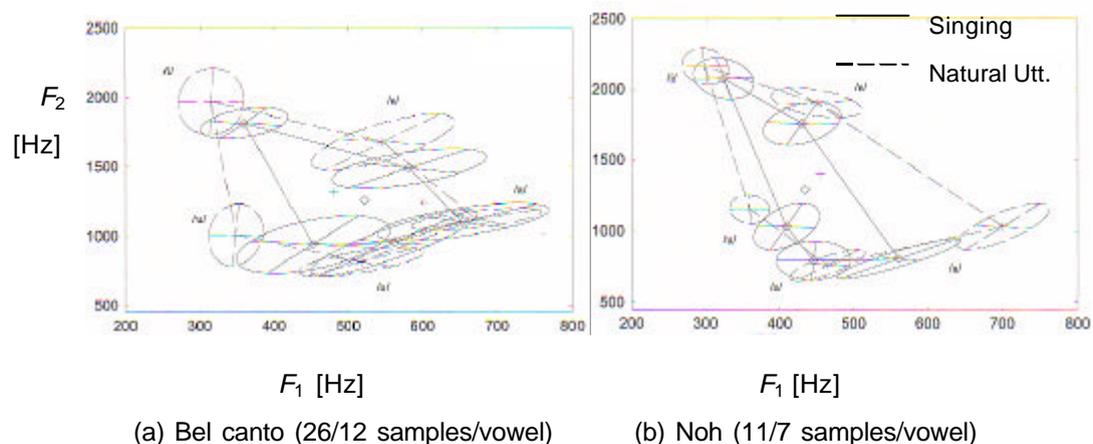
Fig.1 Formant shift for singing from natural utterance.
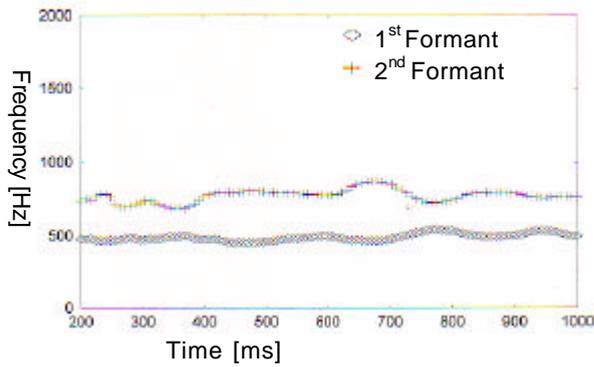
Fig.2 Trajectories of the first and second formant
frequencies of allophonic /a/ in Noh.
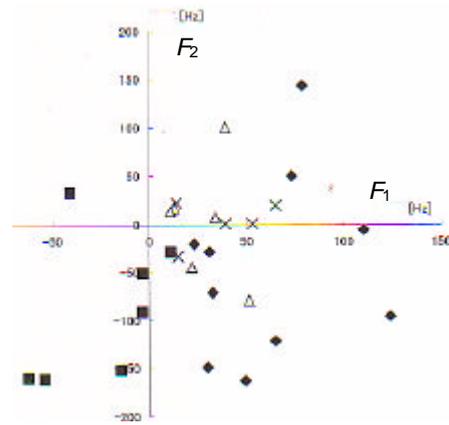
(■:Bel canto, ◆:Noh, △:Kyogen, ✕:Amateur)

Fig. 4   Deviation of formant frequencies
from natural utterance to singing mode on
F_1. F_2 plane.
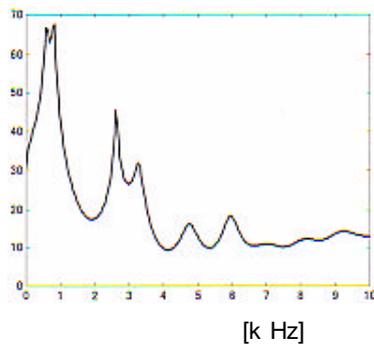
[k Hz]	[k Hz]
(a) /a/ by Tetsunojo KANZE of Kanze school	(b) /a/ by Sensaku Shigeyama of Okura school
(perceptually, close to /o/)	(similar to natural utterance, but has singer's formant)

Fig.3 Comparison of typical frequency spectra of singing /a/ of Noh and Kyogen.

Discussion from a Cepstral View Point

As is shown in the previous section, formant frequencies of some genres deviate from typical values for each vowel. The situation is investigated in the cepstral space, as automatic phoneme identification is mostly done using LPC cepstral coefficients. Figure 5 (a) shows the results of principal component analysis of cepstral distribution; the abscissa and the ordinate represent the first two principal components. Japanese five vowels in four genres of Japanese traditional singing are plotted being assigned different marks for discriminating vowels, and the ellipses show distribution of the genres. The contribution rate by the first two principal components is 30.5%. Subjects for this data were 8 Noh players, 6 Kyogen players, 4 tenor singers, 5 baritone singers together with 6 amateurs for reference. All the subjects are male. At recording of singing voices, the height and loudness were not specified, so the singers could utter at their desirable height and loudness. Recording was made in anechoic chamber, and each vowel was uttered independently or separately from the previous utterance.

Distribution in Fig. 5 (a) shows vowel dependency. To investigate the characteristics of the genres, phoneme-independent distribution is depicted for each genre as an ellipsoid in Fig. 5 (b),

where you can compare distributions of singing voices and natural utterances of the same person. The bold face ellipses are singing voices, while those of thin lines are natural utterance. Phonemic features were removed by subtracting the average value from cepstral data of each vowel.

(a) Principal component analysis of cepstral distribution.

(b) Phonemic-feature-free distribution
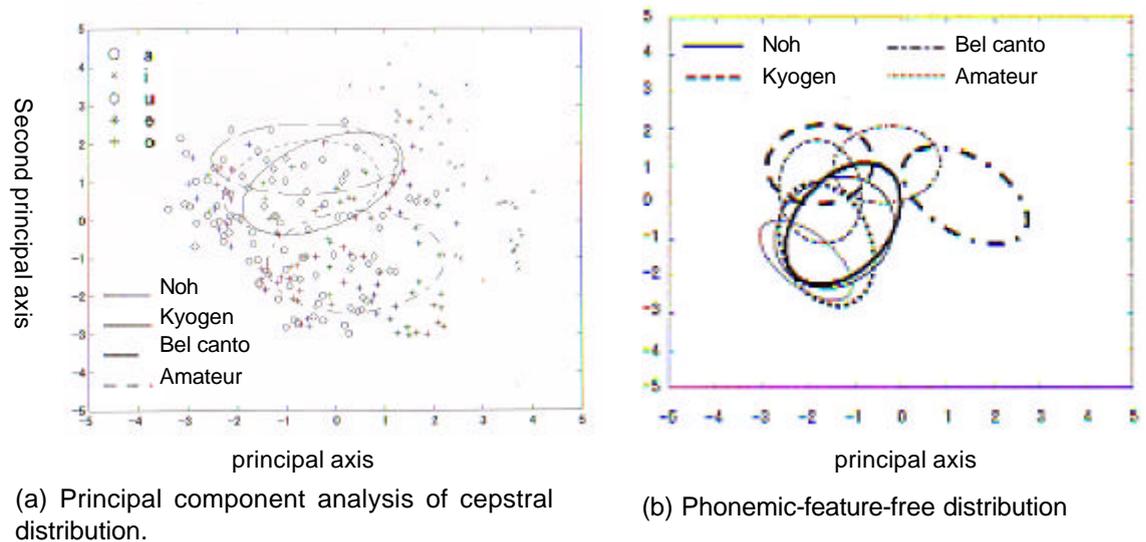
Fig.3 Principal component analysis of cepstral distribution for each vowel and genre, and vowel-independent distribution for each genre.

VIBRATO

Features of vibrato are completely different for Japanese traditional singing and bel canto. Though the difference is perceivable even to naive listeners, there has been no quantitative investigation up to now. Followings is brief survey of vibrato in Japanese traditional singing compared to that in bel canto.

(a) Noh (b) Kyogen (c) Biwa

(d) Shomyo (e) Kabuki (f) Nagauta
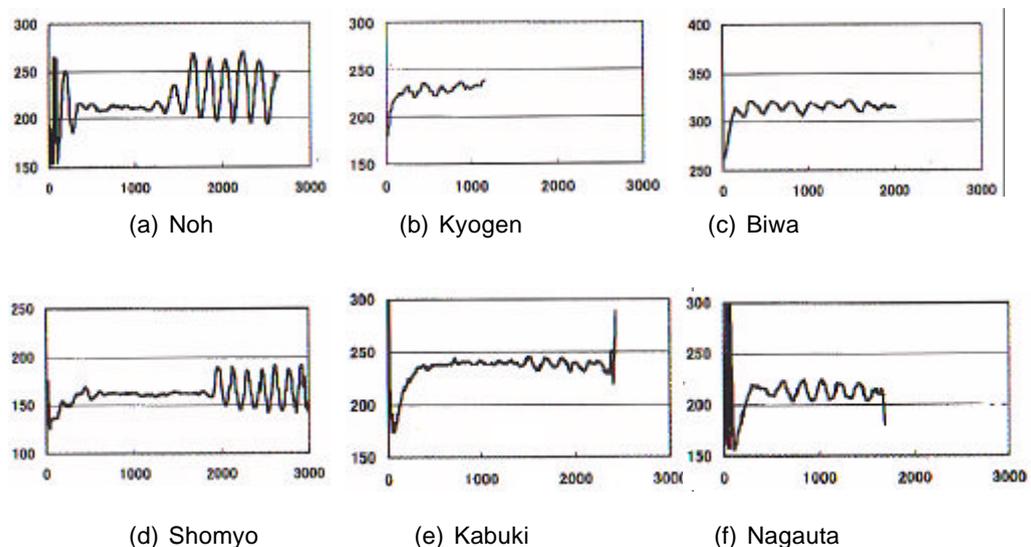
Fig.6 Examples of vibrato patterns of Japanese traditional singing.
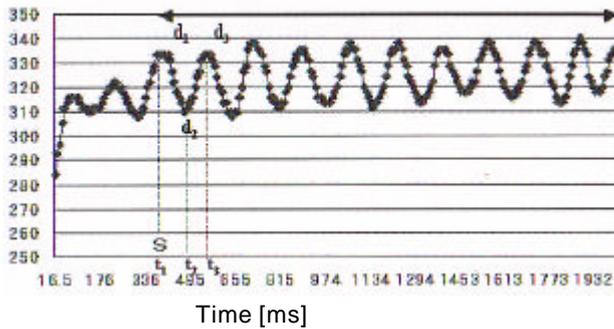
Time [ms]

Fig. 7   A typical vibrato pattern of bel canto.
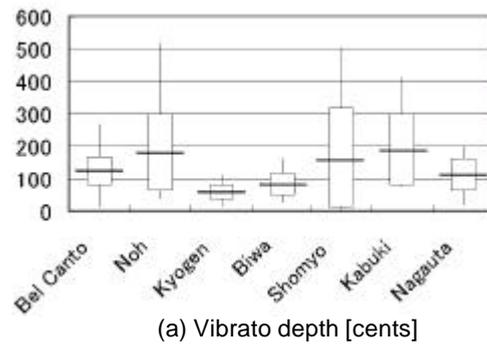
(a) Vibrato depth [cents]

Fig. 8   Comparison of depth and build-up time
of vibrato in bel canto and Japanese
traditional singing.

(Indicated are mean ± ó, max and min values)
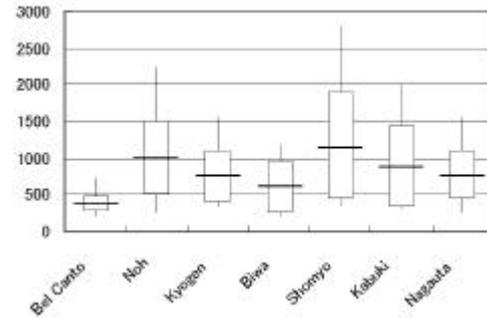
(b) Build-up time [ms] of vibrato

Various typical vibrato patterns of Japanese traditional singing are shown in Fig. 6, compared to that of bel canto shown in Fig.7. As is seen in Fig. 6, vibrato patterns of Japanese singing are irregular and full of varieties while vibrato in bel canto is stable and it keeps roughly constant depth and speed. The vibrato depth ranges from minor second to perfect forth for Japanese singing, while it is either minor second or major second for bel canto. No difference is recognized in vibrato speed between Japanese singing and bel canto. Figure 8 compares of vibrato depths and build-up time of vibrato between bel canto and various Japanese singing styles. Build-up time for vibrato is usually short and vibrato reaches stable state immediately after the voicing in bel canto, while that in Japanese singing is usually much longer.

CONCLUSIONS

Features of Japanese traditional singing are compared with that of bel canto, mainly from a view point of phonemic features and vibrato. Phonemic features are discussed from view points of formant frequencies and cepstral parameters.

REFERENCE

[1] Nakayama, I. et al.: Singing Japanese Songs - Database of Japanese Traditional Singing -, 18 CD set, (2002).