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Remarks on the Devoicing Phenomenon of the Japanese /i/ and /u/

Hiromi Ohtaka

1. Introduction

As for the devoicing phenomenon of the Japanese vowels /i/ and /u/ (/u/=unrounded high back vowel), the following facts have been recognized in the previous literature.

1. Among all the five Japanese vowels, /i/ and /u/ are devoiced or lost by far most frequently.
2. /i/ and /u/ are devoiced or lost in between voiceless consonants, and in between a voiceless consonant and a period or /Q/('Sokuon' or a double consonant).

\[ V \rightarrow V/C \rightarrow \begin{cases} \{C\} \\ \{Q\} \end{cases} \]

[+high]

\[ e.g. \begin{array}{ll}
1. \text{hitori} & \text{‘one person’} \\
2. \text{iši} & \text{‘will’} \\
3. \text{−desu} & \text{‘be’} \\
4. \text{kippu} & \text{‘ticket’} 
\end{array} \]

3. The possibility of the occurrence of /i/ and /u/ devoicing increases depending on the kind of the syllable-initial consonant (onset) in the following order.
Plosives (Stops) < Affricates < Fricatives

4. The nuclear vowels /i/ and /u/ in an accented mora (syllable) tend to be less frequently devoiced.

Fact #2 above can be explained in terms of 'economy.' 'Economy' is a universal property of natural languages. When one is speaking, one's vocal cords are vibrating approximately 70 percent of the time [Fry 1979 p.69]. Since both voiced and voiceless consonants occur in speech, it is necessary for the vibratory activity to be switched on and off many times. The aforementioned vowel devoicing rule in Japanese apparently helps with the economy of this voice switching activity in speech.

Fact #4 can be explained by means of the characteristics of the pitch accent structure in Japanese. Japanese is a language that has melody or pitch accent realized by the two phonological units, i.e. [H] (high) and [L] (low). Japanese can be said to have a music scale that consists of only two whole notes instead of seven to make melody. To give a syllable the unit [H] means for a speaker to pronounce it consciously on higher pitch than that with [L]. Therefore, the nuclear vowel in an accented mora tends not to be devoiced. If it were devoiced, the relative difference in pitch between [H] and [L] syllables could not be actually realized onto the phonetic representation level.

On the other hand, no explanation has been given for facts #1 and #3 in the past. This paper is designed to give an explanation of one of these, fact #1.

2. Overtone structure of vowels

As is well-known, the quality of vowels depends upon their overtone structure, i.e. the configuration of a number of different pitches produced simultaneously. There is the pitch at which a vowel is actually spoken, and
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there are the various overtone pitches that give it its distinctive quality. We can distinguish one vowel from another, because each vowel has its own characteristic overtone structure that is audible.

When a person is whispering vowels [i, I, e, æ, a, ɔ, U, u] as in the words "heed, hid, head, had, hod, hawed, hood, who'd," the vocal cords are not vibrating, and also there is no regular pitch of the voice, because whispering sounds are made by the air stream with aperiodic wave-motion in the aural cavity. This articulatory condition is exactly the same as that when vowel devoicing occurs. In this condition, we can still hear that the vowels whispered form a series of sounds on a continuously descending pitch. This is because we hear one of the overtones that characterize vowels. Therefore, one can say that devoiced vowels still maintain enough recoverability as vowels to make a listener recognize them likewise. This is one of the important points to understand why vowel devoicing can occur in Japanese.

The loudness of the particular overtone recognized in a devoiced condition is maximized for high vowels like [i] and [u], because the space between the tongue and the hard palate is then most narrowed.

In the case of high vowels, the space is much narrower than that of other vowels. Physically speaking, this means that the air stream exhaled by the lungs for high vowels is given higher velocity through the space relative to other non-high vowels on condition that there is no change in respiratory energy. As a result, the devoiced sound for high vowels can make its overtone quality more audible than that for non-high vowels, because the devoiced sound that consists of aperiodic wave-motion can become louder in proportion to the rise of velocity. This is one of the reasons that vowel devoicing occurs exclusively more often on /i/ and /u/ than on non-high vowels in Japanese.
3. Characteristics of respiratory energy in Japanese

In English a stressed syllable is produced by pushing more air out of the lungs in one syllable relative to others, because it has greater respiratory energy than neighboring unstressed syllables.

On the other hand, this is not the case in Japanese. All Japanese syllables are produced with the same degree of respiratory energy because of no stress. This is another reason that vowel devoicing occurs in most cases on /i/ and /u/, because this characteristics of Japanese causes devoiced high vowels to make their overtone quality relatively more audible than the devoiced non-high vowels on condition that all syllables are produced with the same degree of respiratory energy from the lungs.

4. Conclusion

In conclusion, there are two reasons to answer the question why vowel devoicing can occur in the aforementioned phonological environments in Japanese. These reasons are as follows:

(1) In human speech, 'economy' is universal.
(2) Even when vowels are devoiced, they can maintain their characteristic vowel qualities.

And in addition to these, one needs two more reasons to answer the question why the Japanese high vowels /i/ and /u/ are exclusively devoiced in most cases relative to other non-high vowels. These two reasons are as follows:

(3) When vowels are devoiced, the loudness of a particular overtone is maximized in high vowels on condition that all syllables are produced with the same degree of respiratory energy from the lungs.
(4) Japanese is a language in which all syllables are produced with the same degree of respiratory energy from the lungs because of no stress. This causes high vowels to get devoiced more frequently than
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non-high vowels.

References