JAPANESE PHONEMIC CONTRASTS INVOLVING PHONE LENGTH

Mike Olsen

ABSTRACT

There are interesting phonetic features in each language that make them different from other languages; Japanese is no exception. In order to understand the phonetic features of Japanese, I recorded word lists from a native speaker through a series of elicitation sessions. This data provides information on the participant's linguistic background, an overview of the phonetic features found in Japanese, and a discussion of phone length; one feature that differentiates Japanese from many of the world's languages.

1. INTRODUCTION

Certain contrasting features are evident across the world's languages. These features involve changes in the shape of the vocal tract being created by interaction between the glottis, tongue, velum, and specific places in the oral cavity. Each language has a different inventory of sounds that it utilizes, pulling from different manners and places of articulation. Some languages share the majority of their sound inventories while others make contrasts that are not found in many other languages.

Japanese, like all languages, utilizes a variety of sounds to form phonemes that, when combined with each other, form morphemes and lexemes which convey meaning. This report explores the contrasting features that exist in Japanese found through a series of speech elicitation sessions with a native Japanese speaker. Background information on the speaker is provided for context of the particular idiolect observed. A focus on a particular prosodic property that is interesting in Japanese is also presented.

2. PARTICIPANT

Megumi Eckert agreed to have her speech recorded in order to analyze her speech sounds. She was born in Yokohama, Japan and lived there until she was eight years old. At eight, she moved to Chigasaki, a city located in the same geopolitical division as Yokohama. Both cities are located in the same dialectal region as Tokyo.

In Chigasaki, Megumi learned the standard language, known as *Hyojungo* by the Japanese [1], in her home and with friends. This is also the dialect that she studied at school. Because of her homogenous linguistic background, Megumi doesn't speak other Japanese dialects. She did mention that she could probably learn other dialects, but that it would require "considerable time and effort".

English is Megumi's second language. Her experience with English was typical of most Japanese students; she studied for three years in junior high school and for three more years in senior high school [1]. Despite these years of study, she didn't like learning English in school. It wasn't until she wanted to broaden her career opportunities that she decided to truly learn English.

In 2001, Megumi traveled to New Orleans to take an intensive English course. Since then, she has lived in the United States and continues to improve her English.

3. PHONETIC FEATURES

Stop consonants, fricatives, approximants, vowels, and prosodic elements are among the contrasting features encountered in elicitation sessions that are used in Japanese. This section presents a brief overview of the phones evident in the data collection.

3.1. Stop consonants

Upon examining the elicited responses, I found that Japanese displays a variety of stop consonants. All the possible bilabial stops [p], [b], and [m]; all the possible alveolar stops [t], [d], and [n]; and velar plosive stops [k] and [g] were found. In addition to these, I found the nasal palatal [ɲ], nasal uvular [ɴ], and glottal [ʔ] stops.

Most of the stop consonants I observed occur in word-initial and word-medial positions. However,

the nasal uvular and glottal stops are only found at word-final positions and the other stops, except for one borrowed word from English that terminates in [n] ([baiolin] 'violin'), are not found at word-final positions.

3.2. Fricatives

The fricatives that I found include voiceless bilabial [ɸ], labiodental [f], alveolar [s], postalveolar [ʃ], palatal [ç], and velar [x]. The only voiced fricative I found is the postalveolar [ʒ]. It is important to note that the labiodental [f] appears only in loanwords, such as [fan] 'fan'. I also found two affricate sounds [tʃ] and [dz]. Examples of these affricates are found in [dzembu] 'all' and in [tʃoʃoku] 'breakfast'. All of these fricatives are contrastive exept [ɸ] and [tʃ] which were not found in minimal pairs.

Japanese fricatives appear in word-initial and word-medial positions. Word-final fricatives are not present according to my findings, but I did see word-final affricates (e.g., [satʃ] 'happiness').

Although I did find one case where a fricative precedes a stop [steki] 'awesome', most fricatives are preceded or followed by vowels.

3.3. Approximants

The Japanese approximants include the alveolar tap [ɾ], the palatal approximant [j], the lateral approximant [l], and the co-articulated [w]. They appear in word-initial (e.g., [jɒ] 'world'), in word-medial (e.g., [alu] 'there is') positions.

An interesting observation is that out of all of the elicited responses, there aren't any that begin with the alveolar tap [ɾ]. However, [w] is usually only found in the word-initial positions. There is only one word that we encountered where [w] is found in the word-medial position.

The minimal sets that we extracted from the gathered data suggest that all of the approximants elicited can be said to be in contrast with each other.

3.4. Vowels

In all of the elicited responses, only five different vowels that make up the Japanese system are evident. These vowels are high-front [i], mid-high-front [e], low-front [a], mid-back [o], and high-back [u].

We have seen these five vowels at word-initial (e.g., [ine] 'rice plant'), word-medial, and word-final (e.g., [tamanegi] 'onion') positions. Interestingly, a vowel is added in foreign words ending in non-nasal velar consonants, such as [milukʃeko] 'milkshake' or [saseʒi] 'sausage'. This shows the phonological constraint that nasals are the only consonants found in word-final positions in Japanese.

3.5. Prosodic elements

Japanese is a pitch-accent language. This means that the language utilizes pitch to emphasize particular syllables. This prosodic element is contrastive in Japanese. This can be seen in the examples [xáʃi] 'chopstick' and [xaʃi̍] 'bridge'. The only acoustic feature that differentiates these words is that 'chopstick' has a higher pitch on the first syllable whereas 'bridge' has a higher pitch on the last syllable.

Another use of prosodic elements is evident at the phrasal level. Pitch contouring helps to express meaning. Similar to English, Japanese utilizes higher pitch to show excitement, higher intensity to show anger, and a rising intonation and intensity to indicate a question.

4. PHONE LENGTH

Although there are many different possible gaps of Japanese phonetics, from a holistic perspective, phone length is an interesting observation that I made early on in the elicitation sessions. Often when I would restate a word to make sure I understood the correct pronunciation, Megumi would correct me and sometimes say that what I had said was a different word. She would also try to clarify what I would say by saying something similar to: "did you say [oki] or [oːkiː]? because they are two different words". These types of interactions introduced the prosodic property of phone length.

4.1. Gemination

Ladefoged defines geminates as "long consonants (or vowels) that can be analyzed as double consonants (or vowels)" [2]. In most languages, gemination is not productive in the creation of phonemes and only occurs in allophonic variation. This, however, is not the case in Japanese.

I chose to further explore gemination because it is contrastive in Japanese, as is shown below, whereas it is not contrastive at the phonemic level and only occurs at lexical boundaries in English. [2]

4.1.1. Loci of gemination

According to my data, geminate consonants are only found in word medial-position such as in [matːa] 'waited'. Geminate vowels, however can be found in word-initial (e.g., [oːkiː] 'big'), in word-medial (e.g., [ʃoːdʒo] 'young girl'), and in word-final (e.g., [dokoː] 'travel') positions.

An interesting phenomenon that occurs with geminate consonants is that, in the data I collected, the only voiced geminate consonants were the nasals as in [mamːa] 'baby food' and [hanːa] 'flower'. The first example, [mː], was found in one other word and the other example, [nː], was only found in the word shown. Therefore, according to the data collected it appears that the majority of geminate consonants are voiceless.

4.1.2. Contrasting geminates

Of the 302 elicited responses, 49 words involved geminates, 14 of these were found in minimal pairs. If these elicitation responses are representative of the language, approximately 5% of the Japanese lexemes involve geminates.

Table 1 shows minimal pairs involving contrasting geminates. Although more contrasting geminates were elicited, for lack of space, repeated examples of consonant or vowel geminates are not included.

Table 1: Minimal sets demonstrating contrasting geminates in Japanese (glosses are indicated below each segment)

(1)	[bataː] butter	[batːaː] batter	[batːa] grasshopper
(2)	[mama] mother	[mamːa] baby food	[maːmaː] so so
(3)	[butsu] thing	[buːtsu] boots	
(4)	[xai] Yes	[xaːiː] ashes	
(5)	[xi] Fire	[xiː] grand	
(6)	[neko] Cat	[nekːo] root	
(7)	[steki] awesome	[steːki] steak	
(8)	[toɾi] Bird	[toːɾi] street	

4.1.3. Acoustic Evidence

A statistical analysis of the acoustic data shows evidence of contrasting differences. First, each geminate feature encountered in the responses was measured in milliseconds. A set of regular features was selected and also measured in milliseconds. Features were selected at random from various word positions (initial, medial, and final) until the number of regular features matched the number of geminates. The mean length (ML) of the geminate features (consonants and vowels) was measured and compared to the ML of the regular features (consonants and vowels). Measurements were taken from waveforms and spectrograms, from one consonant-vowel boundary to another. Consonant measurements included closures and bursts where applicable. Examples of how measurements were taken can be seen in figures 1-7; the vertical lines in the waveforms and spectrograms are where measurements start and stop.

A summary of the descriptive statistics can be seen in table 2. The ML of the geminate vowels (n=37, sd=83) was 270 ms and the ML of the regular vowels (n =37, sd=24) was 89 ms. For consonants, a similar pattern emerged. The ML of geminate consonants (n =11, sd=66) was 306 ms and the ML of the regular consonants (n =11, sd=45) was 99 ms. A t-test was performed (α=.05) on each set of features to see if the MLs measured were significantly different. Results showed that

the difference between mean regular vowel lengths and mean geminate vowel lengths was significant (p<.001). The difference between mean regular consonant lengths and mean geminate consonant lengths was also significant (p<.001).

Table 2: Descriptive statistics of geminate features measured

Features and statistics	Geminate	Regular
Vowels		
N	37	37
ML (in ms)	270	89
SD	83	24
Consonants		
N	11	11
ML (in ms)	306	99
SD	66	45

The tests results show a significant difference between ML in both consonants and vowels, which means that there is a clear contrastive difference between geminate features and regular features.

Figures 1-3 show an example of a typical minimal pair that involves gemination. Figures 2 and 3 do not form a minimal pair, but they both form a minimal pair with Fig. 1

Figure 1: Wave form and phone measurement in milliseconds for [mama] 'mother'

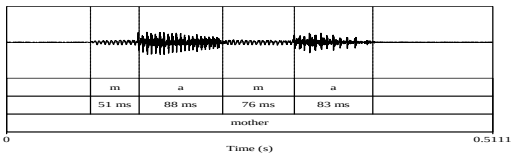


Fig. 1 is an example of regular consonant and vowel length. These numbers are reflected in the aforementioned data. This also gives us a basis on which to compare Figures 2 and 3. All of the phones in Fig. 1 are well under 100 ms.

Figure 2: Wave form and phone measurement in milliseconds for [mam:a] 'baby food'

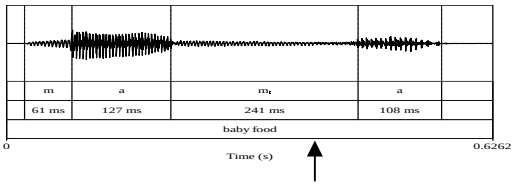


Fig. 2 shows a distinction in the [m] in the word-medial position. This consonant is much longer (241 ms) than the [m] in the word-medial position in Fig. 1. It also appears to have an effect on the surrounding vowels which are somewhat longer than those found in Fig. 1.

Figure 3: Wave form and phone measurement in milliseconds for [ma:ma:] 'so-so'

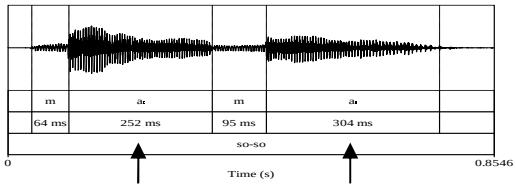


Fig. 3 shows a distinction in the vowels. Notice that the [a]s are considerably longer than those in either Fig. 1 or Fig. 2. The consonants do not appear to be effected by the geminate vowels.

Together, the acoustic evidence of differentiated phone length and the minimal pairs involving geminates show that Japanese utilizes length in both vowels and consonants to produce contrasting perceptual effects.

4.2. Vowel deletion

Another phenomenon in Japanese that has to do with perceived phone length is vowel deletion. This phenomenon was observed when the same English word produced different elicited responses at different times. In talking to Megumi and her husband, who also speaks Japanese (not a native speaker), about her particular dialect of Japanese, the topic of vowel deletion came up.

Vowel deletion, like gemination, was also observed when two different pronunciations were used for the same word. At least once, Megumi deleted a vowel and 'corrected' her pronunciation by restating the word with a vowel.

Figures 4 and 5 show the different pronunciations of the Japanese word for love. The vowel in question is located in a word-medial position between two voiceless consonants. In Fig. 4, there is no evidence of a vowel before [k]. The high energy in higher frequencies with a lack of formant structures is indicative of the alveolar palatal [s]. Fig. 4 also shows no evidence of F_0 traces before [k]. Therefore, the vocal folds are not involved at this point of speech production.

This production is contrasted in Fig. 5. The F_0 trace clearly shows vocal fold involvement before [k].

Figure 4: Spectrogram and pitch contour of [sku] 'love'

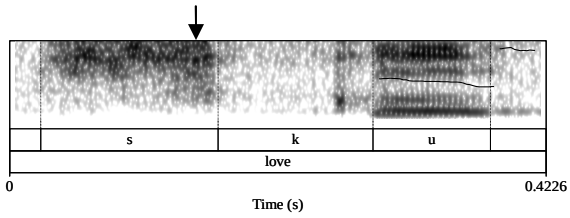
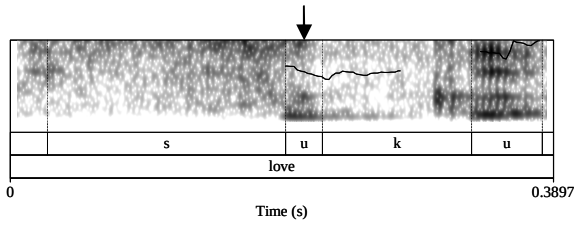


Figure 5: Spectrogram and pitch contour of [suku] 'love'



Figures 6 and 7 show the different pronunciations of the Japanese word for happiness. In this case, vowel deletion occurs after a voiceless affricate and is found at the word-final position. Again, the absence of an F_0 trace in Fig. 6 is indicative of the lack of vocal fold movement. However, in Fig. 7 an F_0 trace is visible following [tʃ].

Figure 6: Spectrogram of [satʃ] 'happiness'

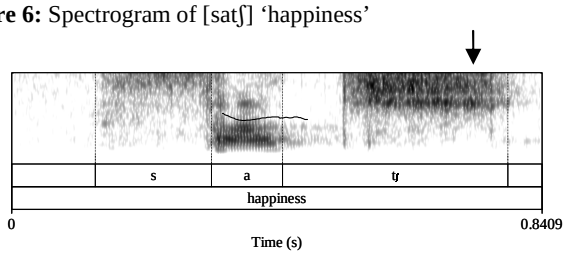
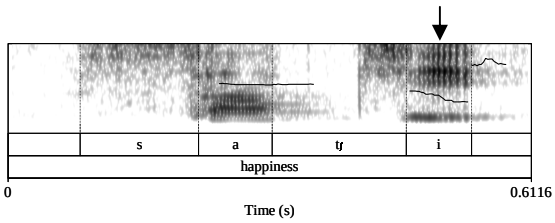


Figure 7: Spectrogram of [satʃi] 'happiness'



From the data gathered it appears that vowel deletion occurs only in environments that include voiceless fricatives and affricates. Although this may be the case, a larger sample of data is necessary to confirm this hypothesis.

5. CONCLUSION

Japanese uses a variety of phonetic features to produce contrastable phones for the purpose of communication. This is evidenced by elicitation responses gathered through a series of recording sessions. Stop consonants, fricatives, approximants, vowels, and prosodic elements combine to produce speech patterns discernable by Japanese speakers. These reproducible acoustic effects allow Japanese speakers to convey thoughts and communicate in a way that "is unique to the human species" [3].

Although Japanese has many interesting phonetic features, phone length is an important feature that sets Japanese apart from many of the world's languages. Acoustic evidence submitted to statistical tests shows that a distinction is made between long and short phones. This distinction allows speakers to make phonologically meaningful contrasts and aides them in producing communicative utterances using phone length.

Collecting acoustic data and analyzing it using computer software has been very informative in understanding phonetics in ways that are both specific to Japanese and in general. Although findings reported herein are enlightening about the acoustic properties of Japanese, a holistic view of the Japanese language has by no means been reached. Further investigation of phonetic features, including a broader range of elicited responses, is needed to arrive at that type of understanding.

6. REFERENCES

[1] Asha, R.E. (Ed.) (1994) *The Encyclopedia of Language and Linguistics*. Great Britain, Pergamon.p. 1800-1814.

[2] Fromkin, V. & Rodman, R. (1998). *An introduction to language*. New York: Holt, Rinehart and Winston.

[3] Ladefoged, P. (2006). *A Course in Phonetics*. Boston: Thomson Wadsworth.