Durational properties of emphatic consonants in Japanese∗

Shigeto Kawahara
Rutgers University
kawahara@rci.rutgers.edu

Abstract

Languages that exploit a duration-based length contrast usually make use of a binary contrast; i.e. short vs. long. In colloquial Japanese, however, speakers can use consonant lengthening for emphasis, and this lengthening can have multiple degrees. This paper reports the first experimental documentation of this emphatic lengthening pattern. The results show that at least some speakers show six levels of distinctions in duration, whereas other speakers show less clear distinctions among different levels of emphatic consonants. Nevertheless, most if not all speakers did show a steady linear correlation between duration and emphatic levels. It is concluded that Japanese speakers do possess articulatory control that allows them to make durational distinctions which go beyond a binary distinction.

∗The recording for this experiment was conducted while I was a visiting scholar at International Christian University, which was made possible by a fellowship offered by the Japan ICU Foundation, for which I am grateful. The help by research assistants at the Rutgers Phonetics Laboratory with the acoustic analysis was indispensable. John Kingston offered both encouragement and very helpful comments on this project. Remaining errors are mine.
1 Introduction

Many languages exploit a lexical contrast between a short consonant (singleton) and a long consonant (geminate): e.g. Arabic (Ham, 2001), Bengali (Lahiri and Hankamer, 1988), Berber (Ridouane, 2010), Bernese (Ham, 2001), Buginese (Cohn et al., 1999), Finnish (Engstrand and Krull, 1994), Cypriot Greek (Tserdanelis and Arvaniti, 2001), Guinaang Bontok (Aoyama and Reid, 2006), Hindi (Ohala, 2007; Shrotriya et al., 1995), Hungarian (Ham, 2001), Italian (Esposito and Di Benedetto, 1999; Payne, 2005, 2006; Pickett et al., 1999), Japanese (Kawahara, to appear), Madurese (Cohn et al., 1999), Malayalam (Local and Simpson, 1999), Pattani Malay (Abramson, 1987), Persian (Hansen, 2004), Swedish (Engstrand and Krull, 1994), Swiss German (Kraehenmann and Lahiri, 2008), Toba Batak (Cohn et al., 1999), Turkish (Lahiri and Hankamer, 1988), among many others (see Ridouane 2010). For example, in Japanese [kata] means ‘frame’ and [katta] means ‘bought’. In most languages with such a length contrast, the contrast is binary; that is, the distinction is a matter of short vs. long.

There are rare cases in which the contrast is arguably ternary: short, long, vs. overlong (e.g. Estonian: Prince 1980 and Saami: Bals Baal et al. 2012). However, ternary length contrasts are very rare at best cross-linguistically, and even in languages that do have ternary length contrasts, morphological and other factors are likely to be involved in licensing the presence of overlong consonants.\(^1\) To the best of my knowledge, there are no languages that make a four-way length distinction.

However, in casual speech of Japanese, speakers lengthen consonants to express emphasis (Aizawa, 1985; Kawahara, 2001; Nasu, 1999), and there can be multiple degrees of length contrasts, beyond a short-long binary distinction. Japanese gemination is orthographically expressed with a small diacritic letter preceded by the target consonant (or the mora containing that consonant), as shown in the example (b) in Table 1. Japanese speakers can take an adjective form like (c), for example, and geminate the (word-medial) consonant to express emphatic meanings, as in (d). In casual speech, we observe examples in which consonants are accompanied by a number of

\(^1\)As Prince puts it (1980: 511), in Estonian “the distribution of overlength, is richly and curiously connected with patterns of morphology, syllable structure, and stress.” See also Bals Baal et al. (2012) for the case of Saami.
gemination marks, as in (e-h).

Table 1: The Japanese orthographic system for gemination

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. かた</td>
<td>kata</td>
<td>'frame'</td>
</tr>
<tr>
<td>b. かった</td>
<td>katta</td>
<td>'bought'</td>
</tr>
<tr>
<td>c. かたい</td>
<td>katai</td>
<td>'hard'</td>
</tr>
<tr>
<td>d. かったい</td>
<td>kattai</td>
<td>'hard' (emphatic)</td>
</tr>
<tr>
<td>e. かっ っ たい</td>
<td>kattta</td>
<td>'hard' (very emphatic)</td>
</tr>
<tr>
<td>f. かっ っ っ たい</td>
<td>kattttai</td>
<td>'hard' (very very emphatic)</td>
</tr>
<tr>
<td>g. かっ っ っ っ たい</td>
<td>kattttta</td>
<td>'hard' (very * 3 emphatic)</td>
</tr>
<tr>
<td>h. かっ っ っ っ っ たい</td>
<td>kattttttai</td>
<td>'hard' (very * 4 emphatic)</td>
</tr>
</tbody>
</table>

The aim of this project is to investigate the phonetic characteristics of this multiple-level emphasis pattern, the primary question being how many levels of distinctions speakers can actually realize acoustically. While phonetic properties of Japanese geminates have been investigated in many instrumental studies in the past (see Kawahara to appear for a recent overview), this multiple emphasis pattern has not been investigated from a phonetic/instrumental perspective. This paper thus offers the first experimental documentation of this multiple emphasis pattern.

2 Method

2.1 Stimuli

This study measured the duration of various types of emphatic consonants: [t, d, s, z]. In order to control for the effect of place of articulation on duration (Maddieson, 1997), the experiment used only coronal consonants. For each sound, two adjectives were chosen, because adjectives are semantically most prone to emphasis. The adjectives used in this experiment, listed in Table 2, were all disyllabic and lexically accented on the second syllable (i.e. they all had a HL falling pitch contour on the second syllable). The target consonants were always placed in word-medial

---

Japanese does not possess approximant geminates (Kawahara, to appear). Japanese does have nasal geminates, but geminating nasals for emphatic purposes is disfavored (Kawahara, 2012). This study therefore focused on obstruent geminates.
position. Each adjective was paired with a subject noun to make a sentence: e.g. [ano koogi uzai] ‘that lecture is annoying’.

Table 2: The list of the stimuli

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[t]</td>
<td>[d]</td>
<td>[s]</td>
<td>[z]</td>
</tr>
<tr>
<td>katai ‘hard’</td>
<td>hidoi ‘awful’</td>
<td>kusai ‘smelly’</td>
<td>uzai ‘annoying’</td>
</tr>
<tr>
<td>itai ‘aching’</td>
<td>kudoi ‘wordy’</td>
<td>musai ‘disgusting’</td>
<td>mazui ‘distastful’</td>
</tr>
</tbody>
</table>

For each adjective, in addition to the non-emphatic rendition, five degrees of emphasis were created; e.g., [katai] (no emphasis), [kattai] (level 1 emphasis), [katttai] (level 2), [kattttai] (level 3), [katttttai] (level 4), and [kattttttai] (level 5), as illustrated in the examples (c-h) in Table 1.

As a result, there were a total of 48 stimuli (4 consonants * 2 adjectives * 6 consonant lengths). A random number was assigned to each stimulus to track which stimulus was actually pronounced.

2.2 Participants

The participants were seven native speakers of Japanese (Speakers FR, FV, SX, EG, NN, LV, TV). They were all undergraduate students at International Christian University (Tokyo). They were paid 500 Japanese yen for their time. They were all in their twenties at the time of recording.

2.3 Procedure

The experiment took place in a sound-attenuated room at International Christian University. Superlab ver 4.0 (Cedrus) was used to present the stimuli. The stimuli and the instructions were all presented in Japanese orthography. In the instructions, the speakers were told that the experiment was about multiple levels of emphasis in Japanese (i.e. that they were going to be reading sentences with multiple gemination marks).

Each block contained all the stimuli. After each block, the speaker took a short break. The order within each block was randomized within each repetition. The speakers were asked to go through eight blocks (48*8=384 tokens), although due to time limitations, one speaker (Speaker NN) could
only complete six repetitions (each speaker was assigned 30 minutes for this experiment).

As a practice session before the main session, all the speakers went through all the stimuli once to familiarize themselves with the stimuli and the task. After the practice phase, they were allowed to ask any questions that they had.

Their pronunciation was directly recorded to a portable recorder, TASCAM DR-40, with a 44.1k sampling rate and a 16 bit quantization level. The experimenter (the author) sat with the speaker throughout the experiment.

### 2.4 Acoustic analysis

To investigate the acoustic realizations of multiple emphatic patterns, this study focused on consonant durations, because they are the main acoustic correlate of Japanese length contrasts (Beckman, 1982; Han, 1962, 1992, 1994; Hirata and Whiton, 2005; Hirose and Ashby, 2007; Homma, 1981; Idemaru and Guion, 2008; Kawahara, 2006). There are other acoustic covariants of Japanese geminates (Idemaru and Guion, 2008; Kawahara, 2006), and a post-hoc analysis on preceding vowel duration will be reported in section 3.3.

The lexical item [kusai] with no emphasis was excluded from the analysis because the first vowel was devoiced (Tsuchida, 1997), and therefore the constriction duration of [s] was difficult to identify in this case. For the emphatic versions of this adjective, however, devoicing did not occur before geminates (see Han 1994; Takeyasu 2012), and therefore they were included in the analysis.

The boundary between the target consonants and the surrounding vowels were placed by inspecting both the waveforms (onset and offset of aperiodic noise for the fricatives) and spectrograms (abrupt cessation of F2 and F3 in particular). Figure 1 illustrates sample waveforms and spectrograms of three tokens of [s] (no emphasis, level 1 emphasis, level 2 emphasis). The acoustic analysis was performed using Praat (Boersma, 2001; Boersma and Weenink, 1999–2012).
Figure 1: Sample spectrograms. The time scales are all 1000ms.
2.5 Statistics

Since there are many comparisons (6 levels of emphasis * 4 types of consonants * 7 speakers), to avoid Type I error, pair-wise comparisons of each emphasis level were not conducted. However, error bars, which represent 95% confidence intervals, are provided in the result figures. They were generally calculated over 16 repetitions of each consonant (2 adjectives * 8 repetitions), except for Speaker NN, non-emphatic [s] (see above), and occasional cases in which speakers skipped some tokens. Post-hoc inspection of the data also suggested that regression analyses would be useful, so they are reported in the result section. All statistical analyses were performed using R (R Development Core Team, 1993–2012).

3 Results

3.1 Individual patterns

Since inter-speaker differences were apparent in the results, the results of individual speakers are reported separately. The result figures have different y-axis scales, as different speakers use different durational ranges (see section 3.2 for discussion).

First, among the seven speakers, two speakers (Speakers FR and TW) seem to make a perfect six way distinction; i.e., the consonant durations for each level of emphasis differ. The results of these speakers are illustrated in Figures 2 and 3.
Figure 2: The average durations of each emphasis level with 95% confidence intervals: Speaker FR.
Figure 3: The average durations of each emphasis level with 95% confidence intervals: Speaker TW.
We observe that there is a large increase in duration from non-emphatic consonants to the level 1 emphatic consonants, and within emphatic consonants there is a steady linear increase in duration as the emphasis level increases.

To assess this linear correlation between emphasis levels and duration within different levels of emphatic consonants, a linear regression was run with duration as the dependent variable and with emphasis level as the independent variable (non-emphatic consonants were not included in this regression analysis because of the non-linearity we observe between non-emphatic consonants and emphatic consonants). For both speakers, the effect of the emphasis level is significant \( t(317) = 38.0, p < .001 \) for Speaker FR and \( t(315) = 19.6, p < .001 \) for Speaker TW. The estimated coefficients of the emphasis level are 86ms and 63ms, respectively—these values are estimates of by how many milliseconds these speakers increase consonant duration per emphasis level.

Finally, to numerically assess the strength of the correlation between emphasis levels and durations, Pearson correlation coefficients \( r \) were calculated. The non-emphatic consonants were excluded from this analysis also, because there are large jumps in duration between non-emphatic consonants and the emphatic consonants. The results show that \( r \) values are .91 for Speaker FR and .74 for Speaker TW, both very high correlations (both significant at the \( p < .001 \) level).

Other speakers also showed a steady increase in duration, but not as clearly as Speakers FR and TW. Speaker EL shows the next highest correlation between emphasis levels and duration, as shown in Figure 4.
Figure 4: The average durations of each emphasis level with 95% confidence intervals: Speaker EL.
Although the speaker does not show a difference between level 4 and level 5 for the two fricatives, there seems to be a clear, general increase of duration as the emphasis levels go higher. The effect of emphasis is statistically significant in the regression model ($t(317) = 17.3, p < .001$), and the coefficient estimate is 30ms. Despite the fact that this speaker does not show differences for some levels of emphasis, the $r$-value for Speaker EL is high ($r = .70, p < .001$). We also notice that the duration range is smaller (about 400ms in Figure 4) compared to the previous two speakers (about 600ms in Figures 2 and 3), and thus this speaker manages to—or at least attempts to—make six level duration distinctions within a smaller duration range. This characteristic is perhaps responsible for the smaller estimate of the effect of emphasis in the regression model.

The next speaker, Speaker SX, shows some increase in duration correlating with emphasis levels, but we observe a number of emphasis pairs that are not different from each other as well, as shown in Figure 5.
Figure 5: The average durations of each emphasis level with 95% confidence intervals: Speaker SX.
The speaker does not show a difference from level 2 to level 4 for [s] and between level 1 and level 2 as well as level 4 and level 5 for [d]. We also notice that this speaker’s duration range is even smaller than Speaker EL (the maximum range is about 300ms in Figure 5). The effect of emphasis is still significant in the regression model \( t(314) = 15.5, p < .001 \), but the coefficient estimate is lower (22ms), compared to the previous two speakers. The smaller coefficient is presumably related to the fact that the duration range is smallest among the speakers we have already seen so far. The \( r \) value is slightly lower than all the previous speakers \( (r = .66, p < .001) \).

Next, as shown in Figure 6, Speaker EG often fails to show differences between emphasis levels in the middle range (between level 1 and level 2 as well as between level 3 and level 4 for [s], and from level 1 to level 3 for the two voiced consonants). It seems almost as though this speaker has a three-way contrast: non-emphatic, emphatic (level 1 to 3 or 4), and very emphatic (level 5). The effect of emphasis is still significant in the regression analysis \( t(310) = 15.1, p < .001 \), and the coefficient estimate is higher than Speaker SX (52ms). Despite the apparent lack of differences in the middle range, \( r \) seems reasonably high \( (r = .65, p < .001) \).
Figure 6: The average durations of each emphasis level with 95% confidence intervals: Speaker EG.
Speaker FV, shown in Figure 7, does show a steady increase in duration, but we observe that the speaker does not show a difference between certain emphatic levels; e.g. level 1 and level 2 as well as level 3 and level 4 for [t]; level 4 and level 5 for [d]; level 3 and level 4 for [s]; level 1 to level 3, and level 4 and level 5 for [z]. The effect of emphasis is still significant in the regression analysis ($t(275) = 11.3, p < .001$), but the coefficient estimate is low (24ms). $r$ is also lower ($r = .56, p < .001$) compared to the other speakers we have seen.

![Graphs of duration vs. emphasis level for [t], [d], [s], and [z]](image)

Figure 7: The average durations of each emphasis level with 95% confidence intervals: Speaker FV.

Finally, one speaker (Speaker NN) showed a more or less binary distinction—i.e. non-emphatic vs. emphatic, as shown in Figure 8. That is, this speaker does not seem to show distinctions among different levels of emphatic consonants (and this speaker seems to show an evident reversal
between level 1 and level 2 for [z]). Although statistically significant ($t(236) = 3.33, p < .001$), the coefficient estimate in the regression model is as small as 7ms. The $r$ value is also very low ($r = .21, p < .001$), compared to the other speakers.

Figure 8: The average durations of each emphasis level with 95% confidence intervals: Speaker NN.

### 3.2 Summary of the patterns of closure duration

Table 3 provides a summary of each speaker’s behavior. It provides a regression function for each speaker, as well as an $r$ value as a measure of the strength of the linear correlation between emphasis levels and duration. In addition, as a measure of their duration range, the maximum duration is provided.
Table 3: The summary of each speaker’s behavior

<table>
<thead>
<tr>
<th>Speaker</th>
<th>Regression function $y$</th>
<th>$r$</th>
<th>max duration (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaker FR</td>
<td>$y = 124 + 86x$</td>
<td>.91</td>
<td>748</td>
</tr>
<tr>
<td>Speaker TW</td>
<td>$y = 177 + 63x$</td>
<td>.74</td>
<td>804</td>
</tr>
<tr>
<td>Speaker EL</td>
<td>$y = 187 + 30x$</td>
<td>.70</td>
<td>456</td>
</tr>
<tr>
<td>Speaker SX</td>
<td>$y = 155 + 22x$</td>
<td>.66</td>
<td>371</td>
</tr>
<tr>
<td>Speaker EG</td>
<td>$y = 379 + 52x$</td>
<td>.65</td>
<td>888</td>
</tr>
<tr>
<td>Speaker FV</td>
<td>$y = 146 + 24x$</td>
<td>.56</td>
<td>453</td>
</tr>
<tr>
<td>Speaker NN</td>
<td>$y = 179 + 7x$</td>
<td>.21</td>
<td>399</td>
</tr>
</tbody>
</table>

All speakers showed a positive correlation between duration and emphasis levels. Moreover, there are only a few cases of evident reversals, although in a number of cases we observed no differences between certain levels of emphasis.

We also observed that there are noticeable differences among speakers. Two speakers (FR and TW) showed perfect six way distinctions. One speaker (EL) showed some cases in which no differences were observed, but the correlation between emphasis levels and duration was still high. One speaker (NN) made little distinctions among emphatic consonants, although there was a very small correlation between duration and emphasis levels.

In Table 3, we observe an association between how finely each speaker realizes different degrees of emphasis and duration range: for example, Speakers FR and TW, who showed a fine six way distinction, have very large duration ranges. Speaker NN, who showed almost a binary contrast between non-emphatic and emphatic consonants, has a small duration range. The correlation is not perfect, however, since for example, Speaker EL has a high $r$-value, but nevertheless has a relatively small duration range.

To summarize, all speakers showed a positive correlation between emphasis levels and consonant durations, although we also observe inter-speaker variability. Some speakers (especially Speakers FR and TW) seem to have managed to perfectly distinguish six levels of consonantal duration differences. We can thus conclude that (Japanese) speakers have articulatory control that allows them to produce durational contrasts that go beyond a binary distinction. The current experiment included (only) up to 5-level emphasis, and it remains to be seen where there is a limit.
on how many levels of emphasis can be actually produced.

3.3 Is effect of lengthening localized?: the effect on the preceding vowels

This study focused on consonant duration, because the main acoustic correlate of Japanese geminates is constriction duration. However, given the results above, a question arises whether, when Japanese speakers are expressing emphasis, the effect of emphasis is localized to the target consonants. To address this question, a post-hoc analysis analyzed the duration of preceding vowels, taking a subset of the data, namely, that of [katai] ‘hard’, as this word provided the best environment for duration measurement of preceding vowel.³

The results are shown in Figure 4 for each speaker (ordered in the way discussed in Section 3.1 and in Table 3). We observe, first of all, that all speakers show longer preceding vowels in the emphatic conditions than in the non-emphatic condition (except for Speaker NN⁴). This observation matches well with the previous observation about Japanese that preceding vowels are longer before geminates than before singletons (Campbell, 1999; Fukui, 1978; Han, 1994; Hirata, 2007; Hirose and Ashby, 2007; Idemaru and Guion, 2008; Kawahara, 2006; Ofuka, 2003; Port et al., 1987; Takeyasu, 2012). This difference in the preceding vowel duration between pre-non-emphatic positions and pre-emphatic positions found in Figure 4 is thus as expected from what we know about Japanese geminates.

---

³Although the durations of following vowels are also known to be affected by the singleton-geminate difference in Japanese (Campbell, 1999; Han, 1994; Hirata, 2007; Idemaru and Guion, 2008; Ofuka, 2003), they were not analyzed here because we know from the previous literature that the influence of geminates is smaller on the following vowels (Hirata, 2007).

⁴The difference for this speaker was not significant by a Wilcoxon test.
Figure 9: The average durations of preceding vowels for each emphasis level with 95% confidence intervals.
In addition, we observe some differences among different emphatic levels for some speakers, but the tendency is much less clear compared to the differences we observed in consonantal duration. Even the two speakers who showed the clearest six way differences in consonantal durations (Speakers FR and TW) do not show differences in preceding vowel duration among levels higher than 2. Speaker EL also does not show differences for levels higher than level 2. The next three speakers (Speaker SX, EG, FV) only show a difference between non-emphatic consonant (i.e. singleton) and the emphatic consonants (i.e. geminates), reflecting the general tendency in Japanese (see above), but they do not show clear differences among emphatic consonants.

To compare the patterns of consonantal durations and vowel durations, Table 4 summarizes the Pearson correlation values between durations of preceding vowels and emphasis levels for each speaker.

Table 4: The summary of each speaker’s behavior

<table>
<thead>
<tr>
<th>Speaker</th>
<th>$r$</th>
<th>sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speaker FR</td>
<td>.52</td>
<td>$p &lt; .001$</td>
</tr>
<tr>
<td>Speaker TW</td>
<td>.43</td>
<td>$p &lt; .01$</td>
</tr>
<tr>
<td>Speaker EL</td>
<td>.65</td>
<td>$p &lt; .001$</td>
</tr>
<tr>
<td>Speaker SX</td>
<td>-.007</td>
<td>n.s</td>
</tr>
<tr>
<td>Speaker EG</td>
<td>.16</td>
<td>n.s</td>
</tr>
<tr>
<td>Speaker FV</td>
<td>-.02</td>
<td>n.s</td>
</tr>
<tr>
<td>Speaker NN</td>
<td>.14</td>
<td>n.s</td>
</tr>
</tbody>
</table>

Table 4 confirms the observations we made regarding Figure 4. Speakers FR, TW, EL all show some positive correlations, but these values are not as high as those we observed for consonantal durations with these speakers (see Table 3). The other speakers do not show a significant correlation between emphasis levels and preceding vowel duration. It can be concluded that the consonant geminate pattern in Japanese targets consonant duration more than the preceding vowel duration, and the effect of lengthening is localized to consonant duration for some speakers.
4 General discussion

One implication of this study, beyond providing the first experimental description of the emphatic gemination patterns in Japanese, is that Japanese speakers do possess articulatory controls which enable them to potentially make six level distinctions. At least two speakers showed clear six way differences; most if not all speakers show a steady linear correlation between duration and emphatic levels.

One question that arises is, given that speakers can make such fine-grained durational distinctions, why natural languages usually exploit only a two-way (or at most three-way) distinction for lexical contrasts. An obvious hypothesis would be that perception is playing a role here—a three way durational contrast may be difficult to perceive and may cause confusion, which is to be avoided, following the spirit of Adaptive Dispersion Theory (see e.g. Boersma 1998; Diehl et al. 2004; Flemming 1995; Liljencrants and Lindblom 1972; Lindblom 1986; Padgett 2002; Schwartz et al. 1997a,b; see especially Engstrand and Krull 1994 for the relevance of perceptual dispersion in durational dimensions). Another hypothesis is more formal—that phonological systems build on binary distinctive features (of which length contrast is one) (Chomsky and Halle, 1968), so that phonological contrasts are always limited to binary distinctions by Universal Grammar. Settling this debate is beyond the scope of the present paper, and warrants future experimental studies.

The current study also raises further questions. For example, would speakers of other languages be able to make similar durational differences? Would there be a difference between languages that exploit duration-based contrasts (as in Japanese) and those that do not? It can be conceived that emphasis is conveyed by other acoustic dimensions, such as intensity differences. In such cases, would we expect to see the same sort of fine-grained patterns which go beyond binary distinctions? These are interesting questions, which are however beyond the scope of the current study.

Finally, recall that for all the speakers, the emphatic consonants were longer than the non-emphatic consonants (despite that not all speakers realized differences among different levels of emphasis). Moreover, as observed in all the figures, all speakers have a very large increase in duration from non-emphatic consonants to emphatic consonants, and this increase is larger than
the observed differences among emphatic consonants.

It then seems that Japanese speakers overall make a binary contrast between emphatic and non-emphatic durations, and within the emphatic durations, speakers choose different options about how to scale the degrees of emphasis. That is, non-emphatic consonants are not 0 on the scale of emphasis, but instead are categorically different from all emphatics. This pattern may imply that the difference between non-emphatic and emphatic is more important than different degrees of emphasis semantically, and that the speakers are reflecting this difference in semantic importance in their production of emphatic and non-emphatic consonants.

References


Kawahara, Shigeto. 2012. Emphatic gemination in Japanese mimetic words: Wug-testing with
auditory stimuli. Ms. Rutgers University.


