Awareness of L2 Syllable Structures: The Case of L2 Japanese and L2 English

Motoko Ueyama*

1. Introduction

The systematic effect of first language (L1, henceforth) characteristics on foreign or second language (L2, henceforth) speech has been investigated extensively at the segmental level (for reviews, see Flege 1987, 1995; Leather & James 1996). For a valid assessment of how L1 characteristics affect L2 speech patterns, it is also necessary to investigate the suprasegmental or prosodic aspect of language transfer phenomena (for a review of earlier studies of L2 prosody, see Ueyama 2000). In this paper, we present a contribution to the study of a specific aspect of L2 prosody, i.e., L2 speaker’s awareness of the minimal (word level) prosodic units of their target language. In particular, we study the cases of L2 English learned by native Japanese speakers and L2 Japanese learned by native American English speakers.

It is well known that English and Japanese differ in terms of the timing units used in segmenting continuous speech (for a summary, see Beckman 1992; Tajima 1998; Otake 2000b): the stress foot in English (Pike 1945; Abercrombie 1967) and the mora in Japanese (Jinbo 1927; Bloch 1950). In the case of word segmentation, it is reported that monolingual speakers of English use the syllable as the minimal segmentation unit, while monolingual speakers of Japanese use the mora (see Otake and Yamamoto 2001 for a review). For example, the English word *corn* is not further segmented by native speakers of English, since this word is monosyllabic. The same word is borrowed and lexicalized as *koon* in Japanese. By employing the mora as the minimal segmentation unit, *koon* is further segmented into 3 moras (*ko.o.n*) by native Japanese speakers (note that the coda nasal is also counted as an independent mora). The difference between the two languages in terms of which phonological unit is employed as the minimal segmentation unit raises an important question:

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Do L2 speakers of English/Japanese become aware of their respective L2 prosodic word structure? This study attempts to present a partial answer to this question, focusing on phonological awareness by L2 speakers in production.

This paper is structured in the following manner. In the next section, we compare the characteristics of L1 English and L1 Japanese with respect to the structural complexity of syllables and awareness of moras and syllables. In Section 3, we present some research questions regarding the phonological awareness of L2 syllable structures that emerge from the comparison of L1 English and L1 Japanese. In Section 4, the method used to run the phonological survey is described. In Section 5, the results of the survey are presented. In Section 6, findings and problems that concern the results are discussed. Finally, in Section 7, a summary of the study is presented.

2. English and Japanese syllable structure

2.1. Syllable complexity

Languages differ in terms of the possible types of syllable structure they allow. In particular, English allows a more complex syllable structure than Japanese does, as illustrated in Table 1. An English syllable can have a maximum of three and four consonants before and after the nuclear vowel, respectively (i.e., in the onset and the coda of the syllable, respectively), while a Japanese syllable allows a maximum of one consonant in each position. Furthermore, Japanese allows only a nasal stop or the first half of a long consonant in coda position (pan ‘bread’, katta ‘bought’), while English allows more types of consonants.

2.2. Mora and syllable awareness

English and Japanese speakers attribute different internal constituency to the syllables of their languages: Japanese speakers are aware of a subsyllabic unit, the mora, while English speakers are not aware of the presence of moras. This difference affects the way in which speakers segment words into minimal prosodic units. In word segmentation, native English speakers use the syllable as the minimal segmentation unit, while native Japanese speakers use the mora. For example, the English word ten is not further segmented by native English speakers, since this word is monosyllabic. The same word was borrowed and lexicalized in Japanese. It can be predicted that native Japanese speakers would decompose this monosyllabic bimoraic word into two moras, i.e., te-n.

This difference in the way in which syllable-internal constituents are perceived can be represented by the graphs in Figure 1 (for Japanese, the kind of structure proposed by Kubozono (1989) is assumed)². In this figure, the internal representations of the English word /ten/ and the Japanese word /ten/ ‘point’ are compared. The English word consists of three segments forming a CVC syllable. Similarly, the Japanese word consists of three segments forming a syllable, but the sequence can be treated as both one unit (one syllable) or two (two moras) by native Japanese speakers: /ten/ → /ten/ or /te + n/³. A vowel can constitute an independent mora by itself or with a preceding onset consonant. A coda nasal forms an individual mora, and it is called hatsuon or moraic nasal and often transcribed as /N/ in Japanese phonology (see Vance 1987; Shibatani 1990; Tsujimura 1996). In addition to the coda nasal /N/, the second half of a long vowel and the first half of a long consonant

Table 1: Syllable structure in English and Japanese

<table>
<thead>
<tr>
<th>English</th>
<th>Japanese</th>
</tr>
</thead>
<tbody>
<tr>
<td>syllable structure</td>
<td>(C)(C)(C)V(C)(C)(C)</td>
</tr>
</tbody>
</table>

(Kubozono 1989)

— 85 —
English
word
syllable
segment

Japanese
word
syllable
mora
segment

\( t e n \)

\( t e n \)

Figure 1: Syllable structures of English and Japanese in native speakers' awareness

Figure 2: More examples of Japanese syllable structure

(word called \textit{sokuon}) also behave as individual moras in Japanese, and they are represented by /\( R /\) and /\( Q /\), respectively. Examples of the latter two moraic segments inside Japanese syllables are shown in Figure 2. The two Japanese words, /\( /\text{took}/00/\) `Tokyo' and /\( /\text{tatta}/\) `stood', consist of two syllables and are syllabified as /\( /\text{too-k}/00/\) and /\( /\text{tat-ta}/\), respectively. Each syllable of `Tokyo' has a long vowel, /\( 00 /\), and the second half of this vowel is counted as an independent mora. Thus, this word contains four moras, /\( /\text{to-o-k}/00/\) or /\( /\text{to-R-k}/00/\). The word /\( /\text{tatta}/\) contains a long consonant /\( tt/\) in the middle of the word. The first half of this long consonant (i.e., /\( /Q/\) or \( \text{sokuon} /\)) is counted by native speakers as one mora. Thus, this word is seen as consisting of three moras, /\( /\text{ta-t-ta}/\) or /\( /\text{ta-Q-ta}/\).

In addition to word segmentation, evidence for Japanese speakers' awareness of the mora can be found in various linguistic phenomena. For example, the Japanese syllabary writings (called \textit{kana}) are mora-based, in the sense that each letter corresponds to one mora (i.e., the moraic nasal, the first half of a long consonant or the second half of a long vowel and all sequences of onset+short vowel/first half of a long vowel are represented by single letters)\(^4\)). The meter of Japanese poetry (e.g., \textit{haiku}) is based on mora counting, not on syllable counting. Word games played by Japanese children are also based on mora counting (Katada 1990).

Note that there is no corresponding evidence for the existence of the mora in English (e.g., the English version of \textit{haiku}) is based on syllable counting, not mora counting). More evidence shows that English speakers are not aware of the mora. For example, Hayes (1995) observed that native English speakers hear certain sequences in Japanese folk songs as syncopated when they are not. This "perceptual illusion" is caused by the mismatch between the types of fundamental musical beat in the two languages: syllables occupy the musical beat in English, but moras do in Japanese. The absence of the mora from the phonological awareness of English speakers has been observed in recent psycholinguistic studies by Otake and others. For example, Otake and Yamamoto (2001) conducted an experiment in which English monolingual speakers were presented with Japanese spoken words and asked to mark the second natural division point from the onset of the word

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on a transcript of each word, and the results showed that English monolinguals were sensitive to syllables, but not to moras.

3. Research questions

As shown in the review of the previous section, English and Japanese syllable structures show crucial differences in terms of two linguistic properties: 1) structural complexity (i.e., English allows more complex syllables with more consonants than Japanese) and 2) the absence vs. presence of the mora in the speakers' phonological awareness (i.e., the mora is present in Japanese, but not in English). Recent studies reported significant effects of L1 segmentation characteristics on both properties of phonological segmentation in a foreign language (L2 phonological segmentation, henceforth). Regarding structural complexity, Tajima and Erickson (2001) investigated the on-line perception of various syllable structures by monolingual Japanese speakers. The results of their experiments showed a strong tendency for Japanese speakers to break a syllable with consonant clusters into multiple syllables. As far as the second property is concerned, Otake and Yamamoto (2001) conducted experiments in order to see how monolingual speakers of Japanese and English were sensitive to syllables and moras in the two languages. Results showed that monolinguals of Japanese and English are sensitive to moras and syllables, respectively, not only when they segment words in their mother tongues, but also in their L2 (i.e., Japanese for English speakers and English for Japanese speakers).

Another important finding in recent studies regarding the effects of L1 characteristics on L2 phonological segmentation is that Japanese monolingual speakers are also aware of syllables. Otake (2000a) specifically investigated whether monolingual speakers of Japanese and English are aware of moras and syllables when they segment words of their L1, and found that Japanese speakers can spot these two units equally well if they are explicitly asked to pay attention to both, while English speakers are, in the same condition, only sensitive to syllables. Otake hypothesizes that Japanese speakers are aware of syllables because they used to have syllables as the basic prosodic unit during the pre-school period and shifted toward moras only later under the effect of the Japanese writing system. The fact that Japanese speakers are aware of syllables was confirmed by the findings of recent research by Tajima and others (Tajima and Erickson 2001; Tajima et al. 2002).

The results of Otake (2000a) and Tajima and others are in contrast to the aforementioned finding by Otake and Yamamoto (2001) that Japanese monolingual speakers are only sensitive to moras when they segment English words. A crucial difference between these studies is that in the former two studies Japanese participants were explicitly asked to segment words into syllables, while in the latter study the choice of moras or syllables was open to the subjects. This difference could be at the root of the difference in the results: Japanese speakers are able to manipulate syllables, but if they are given a choice, they prefer to use moras.

These studies focused on L1 or on abilities in a foreign language by monolingual speakers. In the current study, we will examine prosodic awareness in L2 as a function of learning by comparing beginning and advanced levels of L2 speakers. Given the results of the studies that we have just reviewed, we predict that Japanese speakers of L2 English will be faster at developing syllable awareness than English speakers of L2 Japanese at developing mora awareness. More specifically, the following questions will be asked with respect to L2 English-L1 Japanese and L2 Japanese-L1 English:

- Do Japanese speakers of L2 English learn to segment English words into syllables without breaking English consonant clusters into moras/syllables?
- Do English speakers of L2 Japanese learn to segment Japanese words into moras (vs. syllables)?

In order to answer these questions, we will conduct a phonological survey in which we asked participants for judgments on word segmentation.
4. Method

4.1. Subjects

Seven speakers of L1 English (NE1–7) and 3 advanced and 4 beginning Japanese speakers of L2 English (AE1–3 and BE1–4, respectively) participated in the English phonological survey. The seven speakers of L1 English were all native speakers of American English who were UCLA undergraduate students at the time of recording. The criterion used to select speakers for the two L2 speaker groups was the number of years of residence in the United States. The three advanced Japanese speakers of L2 English had been staying in the United States for more than 5 years, while the four beginning speakers had never stayed in English speaking countries for more than 3 months. At the time of data collection, all three advanced speakers were UCLA students, while all four beginning speakers were college students in Tokyo, Japan. All 7 Japanese speakers of L2 English speak Tokyo dialect as their mother tongue.

Five speakers of L1 Japanese (NJ1–5) and 3 advanced and 4 beginning speakers of L2 Japanese (AJ1–3 and BJ1–4, respectively) participated in the Japanese phonological survey. The five speakers of L1 Japanese were all native speakers of the Tokyo dialect and college students in Tokyo, Japan. The experimental groups consisted of 7 native speakers of American English learning Japanese (L2 Japanese speakers, henceforth). The three advanced speakers of L2 Japanese had been staying in the Japan for more than 4 years, while the four beginning speakers had never stayed in Japan for more than 3 months. All beginning speakers of L2 Japanese were undergraduates studying Japanese as a foreign language at UCLA.

4.2. Materials

The materials of the phonological survey included bimoraic syllables (with /N/, /R/ and /Q/) and monomoraic syllables (as fillers/controls) for Japanese and almost all possible syllable types for English (we did not include syllables having 4 consonant coda clusters in the English materials). The English corpus consisted of 44 monosyllabic words. The Japanese corpus consisted of 24 words (14 test words and 10 fillers/controls), varying in the number of moras from one to three. The Japanese and English test words are listed in Table 2 and Tables 3, respectively. In both tables, the syllable structure of each test word is presented next to the word. In Table 2, a Japanese long vowel is represented as /VR/, and the position of a lexical pitch accent is indicated by the apostrophe. In Table 3, both English diphthongs and tense vowels are represented as /VV/.

4.3. Data collection and analysis

The data was entirely collected by the author of the present study. The selected words were pseudo-randomized and presented using PsyScope (1993). English and Japanese words were presented in roman alphabet and in a mixture of kana and Chinese characters, respectively (see Table 2 for the orthographic representation of the Japanese test words). Before starting the actual data collection, the author described the procedure of the survey to each participant in the

<table>
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<th>Table 2: The 14 test words of the Japanese phonological survey</th>
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<td>通る</td>
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<td>カード</td>
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</table>
### Table 3: Number of /no/ (representing the segmentation of English words by L1 English speakers and Japanese speakers of L2 English)

<table>
<thead>
<tr>
<th>word</th>
<th>syllable structure</th>
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<th>L2 English</th>
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</table>

| average /no/word | 1.02 | 1.09 | 1.13 | 1.93 | 3.09 | 2.65 | 2.75 | 2.73 | 2.83 |

--- 89 ---
mother tongue of that participant. The procedure was the following:
1) One word is displayed on the computer screen at a time;
2) The participant can practice pronouncing the displayed word until s/he becomes able to say it without a major break or interruption in the middle of the word;
3) The participant paraphrases the word using a sequence of /no/s;
4) The participant can press a button of the keyboard to move on to the next word at any time (i.e., it is a self-paced survey).

When explaining the third step of the procedure, the terms "syllable" and "mora" were not mentioned. Instead, the author gave a description of the target units (i.e., "A word can be further divided into chunks of sounds") and demonstrated how to paraphrase words made of CV syllables (where moras and syllables coincide): e.g., Japanese sakura ‘cherry tree’ becomes no-no-no, English mama becomes no-no.

The participants in the Japanese survey were specifically requested to use /no/, and not /noo/ (with a long vowel), /noʔ/ (with a glottal stop) or /noN/ (with the moraic nasal /N/). This was necessary in order to avoid ambiguities: if speakers parsed a word such as tooru ‘pass’ with the string noo-no, one could not tell whether they replaced the bimoraic syllable too with another bimoraic syllable, or whether they simply preserved the segment length of the first vowel of this word (tooru). On the other hand, if speakers substitute too with no-no, we can be sure that they count it as two moras.

Before starting the survey, participants had a chance to review the list of test words to make sure that they were able to pronounce them comfortably. In the beginning of the survey, they took a short trial session, so that they could familiarize themselves with the procedure of the survey. The data were recorded in the recording booth of the UCLA phonetics lab for the L1 English, experienced L2 English and L2 Japanese groups. The speakers of L1 Japanese and beginning L2 English were recorded in the recording room of Meiji Gakuin University Information Center in Tokyo.

The collected data were transcribed by the author. For English words, all phonetic variations of the syllable no (e.g., [nɔ:], [nɔ:] or [nɔ]) were counted as one count of the same segmentation unit /no/. For Japanese words, only [no] with the short vowel /o/ was used by all participants, since they were instructed to do so. For every word, the number of no used was counted.

5. Results
5.1. L2 English segmentation
5.1.1. L1 English vs. L2 English patterns
For each participant, the counts of no produced in correspondence to all 44 English test words are presented in Table 3. Tense vowels and diphthongs are represented by VV, lax vowels by V. Since all test words are monosyllabic, we expect that every L1 English speaker will replace each English word with 1 count of /no/. Shaded cells indicate non-native patterns, i.e., words produced with more than one /no/. The average /no/ count per word for each participant is presented in the last row.

The results show that for the L1 English group the expected native pattern is dominant. There are 308 cases in total (7 speakers × 44 test words), and 298 cases follow the expected native pattern (a word is parsed as one count of /no/). The average /no/ count per word for each participant is presented in the last row.

5.1.2. Beginning vs. advanced L2 English
We just saw that, while L1 English speakers generally treat English monosyllabic words as one count of the segmentation unit /no/, Japanese speakers of L2 English tend to break down English monosyllabic words into multiple counts of no. Is there any systematic difference between advanced and beginning speakers of L2 English? Do advanced Japanese speakers of L2 English begin to treat monosyllabic English words in a native-English-like manner? In order to answer these questions, we computed the percentage of cases showing a native English-like pattern (i.e.,
an English monosyllabic word is parsed as one count of /no/ for the L2 English data of each speaker (Table 3), by dividing the number of native-English-like responses by the total number of responses. As a reference for the native-English pattern, we conducted the same calculation for each of the L1 English speakers and computed the group average by pooling the averages of the single speakers. The results are shown in Figure 3.

Two advanced speakers of L2 English, AE1 and AE3, showed larger percentages of native-like patterns than the other five speakers of L2 English, AE2 and BE1–4, although these two speakers’ percentages are still much lower than the average percentage for L1 English (32%–44% vs. 96%). This suggests that it is possible to learn to treat an English monosyllabic word as one count of /no/ only to a certain extent, and that it is difficult to master a completely native-like segmentation. AE2 and BE1–4 showed low percentages, all occurring within the same range (lower than 5%), and no beginning L2 speaker showed patterns that were more native-English-like than those of the three advanced L2 speakers. These results imply that there is a positive correlation between how experienced or proficient Japanese speakers of L2 English are and how native-like their segmentation judgments become, although there is no systematic separation between the advanced and beginning L2 English groups.

5.1.3. Syllable or mora?
Which segmentation unit do Japanese speakers of L2 English employ to segment English monosyllabic words, the syllable or the mora? This question can be partially answered by analyzing the results for four words (*I*, *say*, *few*, *kin*), whose syllable structures are also possible in Japanese. The judgments on the segmentation of these words are summarized in Table 4. In L2 English speakers’ judgments, these words correspond to one count of /no/ in some cases, as in

<table>
<thead>
<tr>
<th>word</th>
<th>syllable structure</th>
<th>L1 English</th>
<th>L2 English</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L1 NE1</td>
<td>L1 NE2</td>
</tr>
<tr>
<td><em>I</em></td>
<td>VV</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><em>say</em></td>
<td>CVC</td>
<td>1</td>
<td>1</td>
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<td><em>few</em></td>
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<tr>
<td><em>kin</em></td>
<td>CVC</td>
<td>1</td>
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</tr>
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</table>

Table 4: Results of judgements on the segmentation of English words whose syllable structures are also possible in L1 Japanese
L1 English, and to two counts of /no/ in other cases. This difference can be explained in terms of whether the mora is used or not to segment monosyllabic English words. For example, AE1, AE3 and BE3 segmented say as /no/, while AE2, BE1, BE2 and BE4 segmented it as /no-no/. Two counts of /no/ would surely be evidence of the use of the mora as the unit employed to segment say (i.e., mora-based segmentation of say). The same applies to the other three words, I, few and kin. Among the seven Japanese speakers of L2 English, AE1, AE3 and BE3 treated all four words as one count of /no/, while BE1 treated all four words as two counts of /no/. AE2, BE2 and BE4 showed both types. Although two counts of /no/ indicate the use of mora-based segmentation for English monosyllabic words, one count of /no/ does not constitute solid evidence of the use of syllable as a segmentation unit (i.e., syllable-based segmentation), due to a problem with the method used to collect speakers' judgments in the English survey. Unlike in the Japanese survey, we did not ask participants to use only /no/ with the short vowel /o/. We believe that this is not a serious problem for the interpretation of the L1 English data. As shown in Table 4, we found no single case of two counts of /no/ in the judgments of seven L1 English speakers for the analyzed words (and, as shown in Table 3, which presents all 44 tested words, there was hardly any instance of two counts of /no/ in general). This suggests that one count of /no/ in the L1 English data implies the use of a single unit — the syllable — for segmenting monosyllabic words. However, it is possible that L2 English speakers occasionally used /nno/ instead of /no/ to represent two moras. Thus, we can only conclude that Japanese speakers of L2 English used mora-segmentation in some cases, while L1 English speakers used only the syllable in order to syllabify English monosyllabic words. More data collected following the same method used for our Japanese survey is needed in order to determine whether L2 English speakers ever use the syllable to parse monosyllabic bimoraic words.

5.1.4. Treatment of consonant clusters in L2 English

We measure the structural complexity of a syllable by the number of consonants within the syllable, without distinguishing between onset and coda. A close examination of the L2 data in Table 3 shows that Japanese speakers of L2 English tend to segment a more complex syllable into more counts of /no/. Figure 4 illustrates this by showing the average count of /no/ for words grouped by the number of consonants they contain (e.g., 0 for I (VV), 6 for strength (CCCVCCC)). Results are presented for a representative speaker from each speaker group.

Three distinctive patterns emerge across the three speakers. NE1 in the L1 English group consistently categorized test words as monosyllabic, regardless of how many consonants there are. In contrast, BE1, in the beginning L2 English group, shows a clear positive correlation between the average of /no/ counts and the number of consonants in monosyllabic English words. This indicates that this speaker treats a cluster of English consonants as a sequence of moras or syllables. Finally, Ac2 in the advanced L2 group shows an intermediate pattern.

5.2. L2 Japanese segmentation

5.2.1. L1 Japanese vs. L2 Japanese patterns

The results of the Japanese survey are presented in Table 5. The table shows the numbers of occurrences of the segmentation unit no for 14 test words which include bimoraic syllables (i.e., syllables contain long vowels, the moraic nasal /N/, or coda consonants) for each speaker. Based on our intuition about the tasks, we expected that in L1 Japanese /no/ would be treated as a mora, not as a syllable, since we asked participants to use only /no/ with the short vowel /o/. We expected the moraic nasal, the second half of a long vowel and the first half of a long consonant to be produced as one count of /no/, and this is indeed the pattern shown in the results of our Japanese survey. In Table 5, shaded cells indicate non-native patterns. The expected native patterns are presented in Table 6.

We find that the expected native Japanese patterns are dominant in both the L1 Japanese
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![Graphs showing syllable structures](image)

**Figure 4:** Average number of occurrences of the segmentation unit /no/ as a function of the number of consonants in syllable

**Table 5:** Number of /no/ (representing the segmentation of Japanese words by L1 Japanese speakers and English speakers of L2 Japanese)

<table>
<thead>
<tr>
<th></th>
<th>L1 Japanese</th>
<th>L2 Japanese</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NJ1</td>
<td>NJ2</td>
</tr>
<tr>
<td>/ii/</td>
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<td></td>
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<tr>
<td>/kaa/</td>
<td></td>
<td></td>
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<tr>
<td>/kii/</td>
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</tr>
<tr>
<td>/gitaa/</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>/biru/</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>/tooru/</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>/kaado/</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>/chiizu/</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>/enn/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/senn/</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/koon/</td>
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<td>3</td>
</tr>
<tr>
<td>/tatta/</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>/etta/</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

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Table 6: Expected native patterns in the segmentation of Japanese words

<table>
<thead>
<tr>
<th>word</th>
<th>syllable</th>
<th>mora</th>
<th>segment</th>
<th>word</th>
<th>syllable</th>
<th>mora</th>
<th>segment</th>
<th>word</th>
<th>syllable</th>
<th>mora</th>
<th>segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ii$</td>
<td>VR</td>
<td>no-no</td>
<td>no-no</td>
<td>$tooru$</td>
<td>CVRCV</td>
<td>no-no</td>
<td>no-no</td>
<td>$koon$</td>
<td>CVRN</td>
<td>no-no</td>
<td>no-no</td>
</tr>
<tr>
<td>$kaa$</td>
<td>CVR</td>
<td>no-no</td>
<td>kaado</td>
<td>CVRCV</td>
<td>no-no-no</td>
<td>no-no</td>
<td>no-no</td>
<td>$tatta$</td>
<td>CVQCV</td>
<td>no-no</td>
<td>no-no</td>
</tr>
<tr>
<td>$kii$</td>
<td>CVR</td>
<td>no-no</td>
<td>$chiizu$</td>
<td>CVRCV</td>
<td>no-no-no</td>
<td>no-no</td>
<td>no-no</td>
<td>$atta$</td>
<td>VQCv</td>
<td>no-no</td>
<td>no-no</td>
</tr>
<tr>
<td>$gita$</td>
<td>CVRCV</td>
<td>no-no</td>
<td>no-no</td>
<td>en</td>
<td>VN</td>
<td>no-no</td>
<td>no-no</td>
<td>$itta$</td>
<td>VQCv</td>
<td>no-no</td>
<td>no-no</td>
</tr>
<tr>
<td>$biiru$</td>
<td>CVRCV</td>
<td>no-no</td>
<td>no-no</td>
<td>sen</td>
<td>CVN</td>
<td>no-no</td>
<td>no-no</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

and advanced L2 Japanese groups: four out of five L1 Japanese speakers and 2 out of three advanced speakers of L2 Japanese fully parsed the tested Japanese words into moras. For example, *tooru* 'pass' consists of one bimoraic syllable and one monomoraic syllable (i.e., *too-ru*). This word is parsed as /no-no-no/ (vs. /no-no/) when the mora is employed as a segmentation unit. In contrast, four beginning speakers of L2 Japanese produced non-native patterns, i.e., syllable-based segmentation in most cases. For example, *sen* 'thousand' consists of one bimoraic syllable, and it is parsed as /no/, not as /no-no/, indicating that the syllable is employed as a segmentation unit. Among the four beginning speakers of L2 Japanese, BJ2 and BJ4 produced non-native patterns (syllable-based segmentation) in almost all cases, while BJ1 and BJ3 mixed native (mora-based) and non-native (syllable-based) patterns.

5.2.2. Beginning vs. advanced L2 Japanese

In addition, in order to see the distribution of native Japanese-like patterns across L2 Japanese speakers, we computed and plotted the percentage of cases showing a native Japanese-like pattern for the data of each L2 Japanese speaker (Table 5), by dividing the number of native-Japanese-like responses by the total number of responses (14 for each speaker). As a reference for the native-Japanese pattern, we conducted the same calculation for each of the L1 Japanese speakers and computed the group average by pooling the averages of the single speakers: this average was 96%. The results are presented in Figure 5 (the dotted horizontal line indicates the 100% level). The figure shows the following patterns. All three advanced speakers of L2 Japanese showed high percentages of native-like responses (minimal percentage is 79%). In the beginning L2 Japanese group, two distinctive patterns are found: BJ2 and BJ4 showed low...
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averages (0% and 7%, respectively), while BJ1 and BJ3 showed intermediate patterns.

5.2.3. Which moraic segment is hard to treat as an independent mora?
In Table 5, test words are categorized on the basis of which of the three moraic segments is present in the bimoraic syllable: the moraic nasal /N/, the second half of a long vowel /R/ or the first half of a long consonant /Q/. Examination of the table shows that BJ1 and BJ3 produced more native-like patterns for test words with /R/ than for words with /N/ and /Q/. This indicates that L2 Japanese speakers begin to treat /R/ as an individual mora before they handle the other two types of moraic segments (/N/ and /Q/).

Interestingly, a similar pattern has been observed in earlier research on Japanese folk metrics and on Japanese child language acquisition. In order to assess the degree of independence of moraic segments (including /R/, /N/ and /Q/), Kubozono (1999) examined 100 Japanese folk songs. Kubozono hypothesized that, if phonological segmentation is mora-based, the moraic segment of a bimoraic syllable (e.g., (C)VV, (C)VN and (C)VQ) would be assigned to a separate musical note. The results showed different degrees of independence for the three moraic segments: /R/ > /N/ > /Q/ (the percentages of instances of the relevant segment produced on a separate musical note are 70%, 51% and 36%, respectively). Ito and Tatsumi (1997) investigated the development of the metalinguistic awareness of moraic segments in Japanese first language acquisition. They collected data from 80 children whose ages varied from 3 to 5 years old. Their data show that it takes significantly more time for Japanese children to become aware of /Q/ as an independent mora than of /R/ and /N/.

It is difficult to explain why the second half of a Japanese long vowel /R/ is easier for both L1 and L2 Japanese speakers to perceive as an independent mora than the coda consonants /N/ and /Q/9. However, we may find cues to explain the pattern in the crosslinguistic typology of syllable weight (see Gordon 1999 for a review). As Gordon’s survey shows, in languages with a metrical system sensitive to syllable weight, (C)VV with a long vowel is more likely to be treated as heavy (bimoraic) than (C)VC with a short vowel followed by a coda consonant. Thus, it is also possible that it is easier to learn to treat a (C)VV syllable as bimoraic than to learn to treat a (C)VC syllable as bimoraic.

6. Discussion

6.1. L1 vs. L2 word segmentation
Are L2 speakers aware of L2 syllable structures in the same way in which they are aware of L1 syllable structures? We will try to answer this question by comparing L1 vs. L2 speakers’ judgments on word segmentation in English and Japanese.

6.1.1. Word segmentation in L1 Japanese and L1 English
The results of the English and Japanese phonological surveys confirmed the expected native patterns for each language. L1 English speakers segmented monosyllabic English words with one count of the segmentation unit /no/ in more than 95% cases, regardless of how complex their syllable structure was. L1 Japanese speakers employed the mora in order to segment Japanese test words: syllables including moraic segments (/N/, /R/ or /C/) were treated as two moras in almost all cases. This confirms that the syllable and the mora are used as units of word segmentation in L1 English and L1 Japanese, respectively.

6.1.2. Effects of L1 characteristics on L2 segmentation
Two major patterns emerge from the analysis of L2 English data. The first pattern is that Japanese speakers of L2 English tend to divide single complex English syllables into multiple counts of /no/ by breaking consonant clusters, which matches with the aforementioned finding by Tajima and Erickson (2001). This occurs when the structures of English syllables do not satisfy the constraints of Japanese syllable structure, where no consonant cluster other than /N.Q/ is
allowed and only nasals or the first half of geminate consonants can occur in the coda position. This pattern can be explained by the effects of the structural simplicity of L1 Japanese syllables on the awareness of L2 English syllable structures by L1 Japanese speakers. Alternatively, Japanese speakers of L2 English could be targeting their own epenthetic pronunciation of complex syllables.

The second major pattern observed is the following: some Japanese speakers of L2 English use mora-based segmentation and reanalyze the complex structure of English syllables even though the structures of those English syllables are legitimate in Japanese \(^\text{10}\) (c.f., Table 4). Some Japanese speakers of L2 English show syllable-based segmentation in their L2 English segmentation, while others adapt their L1 Japanese mora-based segmentation, and the distribution of mora- and syllable-based segmentations is not clearly correlated with the English proficiency levels of those speakers. This pattern is different from the results of the study by Tajima and Erickson (2001). As we discussed above, they found that Japanese college students were able to correctly count syllables of English spoken words about 50% of the time on average, and more than 80% of the time in the case of syllable structures legitimate in Japanese. We suspect that this difference stems from the difference in experimental methods. Tajima and Erickson conducted the test by explicitly asking participants to attempt syllable-based segmentation, while the present study implicitly left the choice to the speakers. As a result, what we are testing for is whether speakers unconsciously prefer moras or syllables, rather than whether they would be able to use both. Furthermore, as mentioned earlier, we did not ask the speakers in the English survey to avoid variations of \(\text{no}\) as \(/\text{no}\)/ or \(/\text{nou}\)/. In the case in which Japanese speakers of L2 English produce these variations, we cannot tell whether they are producing a syllable or two moras. Thus, in future research, we will have to control for this.

As for L2 Japanese segmentation, while advanced speakers of L2 Japanese showed mora-based segmentation (the consistent pattern in L1 Japanese), beginning speakers of L2 Japanese used syllable-based segmentation in most cases. This difference is due to a difference in the treatment of bimoraic syllables containing moraic segments: beginning speakers of L2 Japanese treated a bimoraic Japanese word as one count of \(\text{no}\) (i.e., one syllable), while native Japanese speakers and advanced speakers of L2 Japanese treated it as two counts of \(\text{no}\) (i.e., two moras). This indicates that beginning speakers of L2 Japanese tend not to treat moraic segments as individual moras in L2 Japanese word segmentation. However, this pattern needs to be interpreted with caution: it is not possible to conclude that beginning speakers of L2 Japanese are not aware of the presence of the mora. In the case of L2 English segmentation, the larger number of instances of the segmentation unit \(\text{no}\) is a solid piece of evidence for the claim that Japanese speakers decompose an English syllable structure into multiple moras/syllables, due to the negative transfer of L1 Japanese characteristics. However, in the case of the Japanese data, the smaller number of counts of \(\text{no}\) does not necessarily imply that beginning speakers of L2 Japanese use only the syllable without being aware of the mora. If we assume, as commonly done, that Japanese has both moras and syllables (see Figure 1), then we must consider the possibility that beginning L2 Japanese speakers replace each syllable with \(\text{no}\) even if they are aware of the existence of moras. The only thing we can be sure about concerns the awareness of the mora by advanced speakers of Japanese: their native-like judgments on Japanese word segmentation shows that they have learned to analyze the internal structures of Japanese syllables with the use of the mora.

### 6.2. Word segmentation in beginning vs. advanced L2 speech

We have observed an asymmetry between the two L2 types in terms of development in mastery of native-like segmentation by advanced L2 speakers. In both L2 English and L2 Japanese, beginning speakers showed the effect of their L1 segmentation patterns: e.g., the use of the mora and the decomposition of one English syllable
into multiple moras/syllables in L2 English-L1 Japanese; the failure to treat moraic segments as individual moras in L2 Japanese-L1 English (although this is not conclusive, as discussed earlier). However, while advanced speakers of L2 English show a significant amount of non-native patterns in their segmentation judgments, the major pattern of advanced speakers of L2 Japanese is the native-Japanese-like one. This difference is well illustrated by the following observations made by the comparison of Table 3 and 5: advanced speakers of L2 Japanese (AE1–3) showed native-English-like responses in less than 50% cases, while the percentage of native-Japanese-like responses was higher than 79% on average in the data of the advanced L2 Japanese data (AJ1–3).

What causes this asymmetry in the performance levels of advanced L2 English and L2 Japanese groups? One possible factor is the difference between the English and Japanese writing systems. English speakers could be helped in acquiring the Japanese mora category by the Japanese syllabary writings (kana). In the kana system, each letter corresponds to one mora. It is not difficult to imagine that this system consistently reminds English speakers of the existence of the mora (a similar effect was observed in L1 Japanese acquisition by Inagaki et al. (2000)). This type of visual help is not available for Japanese speakers learning English, since in English the writing system does not show the syllabification of words.

The second possible factor is an asymmetry in syllable complexity between L1 Japanese and L1 English. As reviewed earlier, L1 English has much more complex syllable structures than L1 Japanese (see Figure 1). The results of the English survey showed the considerable effects of syllable complexity on the L2 English speakers’ judgments: more complex syllable structures result in more counts of the segmentation unit no. This tendency was observed regardless of proficiency levels (although it is stronger in the data of the beginning L2 English group, which is not surprising).

The final possible factor is the aforementioned difference in the way of giving directions to the participants between the two surveys. As mentioned in Section 4, the participants of the Japanese survey were asked to use only /no/, while the ones of the English survey were not. This setup of the study created an asymmetry between the L2 Japanese and L2 English groups in terms of freedom to choose moras and syllables: i.e., Japanese speakers of L2 English were provided with more freedom than English speakers of L2 Japanese. The earlier review of recent studies showed that native Japanese speakers are able to use syllables in word segmentation, although they prefer moras to syllables if choices are open. The open choice setup of the English survey could have led to more variations in the responses of Japanese speakers of English.

7. Conclusion

In order to find how L2 speakers are aware of the syllable structures of their target language, we conducted a phonological survey for English and Japanese, in which participants were asked to segment words using the segmentation unit no. The expected native pattern was observed in L1 speakers’ judgments on word segmentation: L1 English speakers treated monosyllabic English words as one syllable, while L1 Japanese speakers treated Japanese moraic segments as individual moras. Two major patterns were found in the L2 English speakers’ judgments: first, the decomposition of one English syllable into multiple moras/syllables; second, the use of the mora for English word segmentation. These two patterns indicate that the characteristics of L1 Japanese syllable structure strongly affect the awareness of English syllable structures even by advanced Japanese speakers of English. On the other hand, the L2 Japanese data showed that English speakers become aware of Japanese moraic segments (i.e., of the bimoraicity of Japanese complex syllables), and there is a positive correlation between proficiency levels and the phonological awareness of Japanese moraicity. We also observed that there is a tendency for /R/ to be the first element to be treated as an independent mora. Interestingly, a similar effect has
been observed in Japanese folk metrics and child language acquisition. It is also reflected in the crosslinguistic typology of syllable weight.

These results show an asymmetry between L2 English and L2 Japanese in the ability of becoming aware of the syllable structures of the target language. We discussed various factors that may have caused the asymmetry: 1) L2 Japanese speakers are aided by Japanese kana writing, which cues mora-based segmentation visually; 2) there is an asymmetry in syllable complexity between L1 Japanese and L1 English; 3) there was a difference in the way of giving directions to the participants of the two surveys.

In the end, our findings show how the study of prosodic awareness in L2 is complicated by the presence of a number of possibly relevant factors and interactions. Further research needs to concentrate on teasing apart the effect of such factors.

Acknowledgements

I would like to thank Marco Baroni, Bruce Hayes, Sun-Ah Jun and Haruo Kubozono for their advice; all participants of the phonological surveys; all the people who kindly helped me to recruit the participants of the surveys, especially, Masako Douglas at UCLA and Tetsuya Sano at Meiji Gakuen University. Also, I am very grateful to the two anonymous reviewers for their extensive and helpful comments. Needless to say, I am responsible for any remaining error.

Notes

1) This paper is based on Chapter 5 of the author’s dissertation, Ueyama (2000).
2) In phonological theories, the mora is used to represent syllable weight in order to account for the fact that some phonological phenomena are systematically constrained by how heavy syllables are. For example, in English, a CV with a lax vowel shows phonological behaviors different from those of a CV(V/C) with a tense vowel, a diphthong or a coda consonant. For example, in English, a light CV by itself cannot form an independent word (*/bl/), while a heavy CV(V/C) can form a word by itself (/bl/, /bal/, /bit/). The internal structures of the two types of syllables are distinguished by different representations at the moraic level: light syllables are represented as monomoraic and heavy syllables are represented as bimoraic. In the present paper, we are dealing with speakers’ awareness of moras, and not with whether moras are active or not in phonological processes. Thus, for our purposes, it makes sense to assume a representation of English syllables such as the one in Figure 1.
3) As seen in Figure 1 and 2, we assume that native Japanese speakers are also aware of syllables since they are able to use syllables to segment Japanese words if they are asked to do so (e.g., Otake 2000a).
4) In recent psycholinguistic studies, it has been shown that the Japanese alphabet system, kana, plays a substantial role in developing awareness to the mora in L1 Japanese acquisition (e.g., Inagaki, Hatano and Otake 2000; Ito and Kagawa 2001).
5) It is important to control for the dialectal background of Japanese speakers learning English, since Japanese dialects greatly differ in terms of prosodic patterns.
6) A reviewer pointed out that English orthography might have interfered with the Japanese learners’ ability to access the correct phonological structures of English words, especially for words that contain “silent” vowels, such as eyes, iced, asked, Pete and tribes. Indeed, not all the Japanese speakers in the study were able to pronounce all test words in a native-English-like manner (in particular, BE speakers had pronunciation problems). However, we reviewed the data recorded in step 2) and we did not find any instance of “pronounced silent vowels”.
7) In Table 3, “---” in the cells indicates a difficulty in transcribing judgments due to poor audio quality.
8) Further studies should try to assess whether the tendency to insert /no/ in order to substitute consonantal clusters is correlated with the Japanese tendency to insert an epenthetic vowel in their spoken L2 English, or whether it is independent from this tendency (e.g., by studying whether speakers who do not epenthese are less likely to insert the extra /no/).
9) With respect to /Q/, notice that the failure to parse it as a mora could be due to the fact that English speakers in general have a hard time producing and
perceiving long consonants. Consequently, it is possible that they do not perceive the first half of a geminate as part of the coda of the preceding syllable.

10) A reviewer wondered whether there are differences in the segmentation of English complex syllable structures by Japanese speakers, depending on whether they correspond to legitimate or non-legitimate structures in Japanese: e.g. *kin* (legitimate) vs. *chit*, *dip*, *pit*, and *bid* (non-legitimate); *keen* (legitimate) vs. *deep*, *cheat*, *bead* and *Pete* (non-legitimate). We reviewed the results of the English survey in Table 3, and we did not find considerable differences in the CVC set. However, this effect emerged in the CVVC set. The comparison of CVVC words showed that four out of seven Japanese speakers of L2 English (AE1, AE2, BE3 and BE4) counted *keen* (legitimate in Japanese) as one count of /no/, while only one speaker (AE4) counted all CVVC words (including non-legitimate structures) as single /no/s. The observed pattern of non-legitimate CVCC words can possibly attribute the complex interaction of mora-based analysis and the effects of L1 Japanese phonology: i.e., CVVC including non-legitimate structures is treated as /no-no-no/ (two moras for CVV and one mora for CV with an epenthetic vowel). We should investigate this phenomenon in further studies.

11) Another possible factor concerning the research method relates to word familiarity. Tajima and Erickson (2001), in their experiments, trained Japanese college students with a set of training words and compared their performance on the training materials with their performance of new materials after the training sessions. The results show that the performance levels were significantly better with training materials. This finding suggests that word familiarity with test words could have affected the results of the present survey. Unfortunately, it was not possible to control word familiarity thoroughly. The Japanese test words (Table 2) were selected from words taught in the first year of the Japanese program at UCLA, which means that all L2 Japanese speakers were already familiar with all words of the Japanese corpus. On the other hand, in the case of English test words, some words were adapted from the vocabulary list of the 3-years English curriculum in Japanese junior high school. However, this list did not cover all syllable types tested in the present study. Thus, we had to add words from outside this list.

References


(Received April 14, 2003;)
(Revision received June 26, 2003;)
(Accepted July 8, 2003.)