Japanese Can be Aware of Syllables and Morae:
Evidence from Japanese-English Bilingual Children

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Abstract
This study investigated the metalinguistic knowledge of the internal structure of syllables by Japanese-English bilingual children. Our recent study revealed that Japanese-English adult bilinguals could be aware of two constituents of syllable structure, syllables and morae, depending upon the nature of input materials, while monolingual speakers were aware of morae irrespective of input materials. Three experiments were conducted with 10 bilingual Japanese children, using CVCVNCV materials in Japanese, English and Spanish in order to test whether the same phenomenon could be observed by bilingual children. The subjects were asked to identify the number of chunks within the materials which were presented aurally and to stamp the number of them on a test sheet. The results showed that they preferred morae in Japanese, but syllables in English and Spanish, suggesting that an ability to manipulate two languages freely may have a function to suppress moraic consciousness.

1. Introduction
It is generally assumed that understanding the process of word recognition needs to clarify two aspects. The first is how human listeners extract the acoustic-phonetic information from the speech signal. The second is how human listeners map that information onto the stored knowledge in the mental lexicon [1].

A number of recent studies have revealed that human listeners exploit rhythm-based speech segmentation strategies that are based upon linguistic rhythm [2]. The current experimental data showed that monolingual speakers segment continuous speech with the different phonological information that is related to linguistic rhythm such as syllables, stress and morae [[3][4][5][6][7]. The interesting finding in these studies was that these segmentation strategies were applied not only to native inputs but also to nonnative inputs [3][4][5][6][7]. A study with bilingual speakers also showed that they preferred a single segmentation strategy [8]. These studies seem to suggest that speech segmentation strategies are determined by a single procedure irrespective of one’s linguistic ability, although the phonological information they choose is different.

Although the current studies have advanced the speech segmentation problem remarkably as described above, the second problem has not yet been understood very well. If a word recognition process is considered as a mapping process of the acoustic-phonetic information onto the stored knowledge as defined above, it is inevitable to understand what sort of conscious representations are stored in the mental lexicon of native speakers. One interesting aspect is how speakers are aware of metalinguistic knowledge with respect to syllable structure.

A series of investigation conducted by Treiman and colleagues have revealed that English speakers are aware of onset-rime, the intermediate constituent, within syllable structure [9]. Although the investigation of the intermediate structure is important, it is probably more important to examine whether any speakers can be aware of syllables and morae, each of which is the immediate constituent of syllable structure. In phonology morae are defined as a subsyllabic unit and they are employed in any languages for the purpose of phonological description. It is widely known that syllables are used to represent within-word structure across languages. The question is whether all language users are aware of morae as well as syllables within syllable structure. Since Japanese is a mora-timed language, it is an ideal to pursue this problem.

A previous explicit-segmentation study on Japanese and English reported that Japanese speakers may be able to access to syllables and morae to represent Japanese words [10]. Recent studies on metalinguistic abilities have shown that Japanese illiterate children could be aware of both syllables and morae in Japanese [11][12] and that the order of awareness may be developed from syllables to morae [12]. All these results from preschool children seem to suggest that there is a high possibility that Japanese speakers are aware of syllables and morae during the preschool period. However, it is interesting to note that once the illiterates acquire kana, one of the Japanese orthographic systems, after this period, they are fully aware of morae, including monolingual adult speakers [11][13]. This suggests that full moraic consciousness by Japanese speakers may be triggered by acquisition of kana which enhances Japanese speakers to be conscious to morae because they coincide with kana letters [11][12].

Then, can Japanese speakers be aware of syllables? Our recent study on Japanese-English bilingual adult speakers showed that a syllabic preference was given to English inputs, while Japanese monolinguals did not [13]. This finding may suggest that if Japanese speakers can reach a point where they can command a foreign language at a certain level and input materials are foreign, their preference could be given to syllables within syllable structure. In other words, an ability to manipulate two languages freely may have a function to suppress moraic consciousness to nonnative inputs. Thus, the present study attempted to test whether this hypothesis is correct or not with Japanese-English bilingual children.
2. Experiment 1

Experiment 1 aimed at investigating how Japanese-English bilingual children were aware of phonological units within syllable structure of Japanese materials.

2.1. Method

2.1.1. Materials

The experimental materials were 10 stimulus and 25 filler words in Japanese. The stimuli were 3 syllable-4 mora words, each of which had (C) V.CVN.CV syllables. The stimuli were chosen in such a way that a CVN syllable occurred as the second syllable from the word onset. These words were: akindo, buranko, semento, otenba, pachinko, hotondo, sazanka, amenbo, dotanba and jidanda. Three of them had a morpheme boundary after a dental-alveolar nasal and the rest did not. The filler words were composed of a CV syllable sequence from one to four syllable-mora words.

2.1.2. Subjects

Subjects were 10 Japanese-English bilingual children who were born and raised in Japan, whose age varied from 9 to 14 years old. The mean age was 11 years and 6 months. These subjects spent a part of their life in English speaking countries (the United States and Australia). The mean duration was 4.7 years. The subjects participated in the experiment within 1.1 years after coming back to Japan. At the time when they were tested, they were attending Japanese elementary and junior high schools.

These subjects attended a special English language program in Tokyo areas to maintain their English communication skills after coming back to Japan. At the language program, the instructors used English to communicate with the subjects. The proficiency level was not measured by a certain test. However, all subjects acquired the communication skills in English. Since they attended regular Japanese schools, they could command Japanese as a native language. Thus, it was assumed that they were bilingual speakers of Japanese and English.

2.1.3. Procedure

The materials were recorded by a Tokyo Japanese speaker on a DAT tape in sequence and presented through headphones. Subjects were tested from one to as many as four at one time in a quiet room.

The task was a vocal-motor stamping task, a modified version of the earlier study [11] to assess children’s phonological awareness. This task was designed to test whether subjects were sensitive either to syllables and morae. The subjects were given a persistent stamp and sheets of paper on which five 1 cm x 1 cm squares were printed. They were instructed to listen to each word and to repeat it. Then, they were asked to count the number of chunks within it in their minds and then to stamp the number in the square boxes on the test sheet. The definition of a chunk was not given to the subjects. Instead, during a practice session, a repetition of a nonsense syllable ba from one to as many as four was given to each subject and asked them to count the chunks and stamped. For example, if ba was given, a subject was asked to stamp one in a single square box on the test sheet. Then, if baba was given, they were asked to stamp twice in the two square boxes on it, etc. This methodology was designed not give any hints to subjects about the definition of a chunk.

Syllables and morae were determined by the number of the stamps in the square boxes. For example, if tomato were given, there would be only one possible stamping pattern, namely, three stamps. However, if buranko were given, there would be two possible stamping patterns. The first pattern was three stamps. In this case, this pattern was interpreted as buran.ko. The second pattern was four stamps. In this case, this pattern was interpreted as bu.ran.ko. In other words, the first pattern was interpreted as syllable-sized, while the second pattern was interpreted as mora-sized.

2.2. Results and Discussion

The number of choices for mora-sized and syllable-sized units for ten Japanese stimuli by ten subjects are shown in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>mora-sized</th>
<th>syllable-sized</th>
<th>other</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese</td>
<td>74</td>
<td>1</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 1. The distribution of mora-sized and syllable-sized choices for Japanese materials.

As can be seen from Table 1, the majority of the choice was mora-sized. “Other” category included responses which failed to comply with the instruction (e.g. one stamp (word-based type), four stamps (letter-based type), etc.

The distribution of response types was submitted to a non-parametric Wilcoxon signed test. The Japanese–English bilingual subjects preferred mora-sized choices to syllable-sized choices which was significantly different (Subject analysis: Z=-2.84, p<0.01; Item analysis: Z=-2.87, p<0.01). This result clearly shows that they recognize morae for Japanese materials. In other words, this suggests that Japanese-English bilingual children have morae as a part of their metalinguistic knowledge.

3. Experiment 2

Experiment 2 aimed at investigating how Japanese-English bilingual speakers were aware of phonological units within syllable structure of English materials.

3.1. Method

3.1.1. Procedure

The experimental materials were 10 stimulus and 25 filler words in English. The stimuli were almost equivalent to 3 syllable-4 mora words in Japanese. The stimuli were chosen in such a way that a CVN syllable occurred as the second syllable from the word onset. These words were: appendix, November, remember, veranda, expensive, December, expansion, surrender, momentary, and September.

3.1.2. Subjects

The subjects were the same as the ones in Experiment 1.

3.1.3. Procedure
The materials were recorded from a Random House CD-Rom English dictionary on a DAT tape in sequence and presented through headphones. Subjects were tested from one to as many as four at one time in a quiet room.

The task was exactly the same as the one in Experiment 1. During the practice session, a nonsense syllable ba was repeated from one to as many as four to each subject to see if they could count the number of chunks appropriately.

3.2. Results and Discussion

The number of choices for mora-sized and syllable-sized units for ten English stimuli are shown in Table 2.

<table>
<thead>
<tr>
<th>materials</th>
<th>mora-sized</th>
<th>syllable-sized</th>
<th>other</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>9</td>
<td>83</td>
<td>8</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2. The distribution of mora-sized and syllable-sized choices for English materials.

As can be seen from Table 2, the majority of the choice was syllable-sized. “Other” category included responses which failed to comply with the instruction.

The distribution of response types was submitted to a non-parametric Wilcoxon signed test. The Japanese–English bilingual subjects preferred syllable-sized choices to mora-sized choices which was significantly different (Subject analysis: Z = -2.69, p<0.01; Item analysis: Z = -2.82, p< 0.01) - There was a significant difference between Japanese and English materials for their preference ( $\chi^2$ =130.57, df = 1, p <0.001). This result clearly shows that they recognize syllables rather than morae for English materials. In other words, this suggests that Japanese-English bilingual children have syllables as a part of their metalinguistic knowledge and that their preference was triggered by the English materials.

4. Experiment 3

Experiment 3 aimed at investigating how Japanese-English bilingual speakers were aware of phonological units within syllable structure of Spanish materials.

4.1. Method

4.1.1. Materials

The experimental materials were 10 stimulus and 25 filler words in Spanish. The stimuli were compatible to Japanese 3 syllable-4 mora words, each of which had a CV.CV.CV syllables. The stimuli were chosen again in such a way that a CV syllable occurred as the second syllable from the word onset. These words were: matanza, levanta, vidente, volante, momento, naranja, segundo, talente, domingo and vacante.

4.1.2. Subjects

The subjects were the same as the ones in Experiment 1 and 2.

4.1.3. Procedure

The materials were recorded by a native speaker of Spanish on a DAT tape in sequence and presented through headphones. Subjects were tested from one to as many as four at one time in a quiet room. The task was exactly the same as the one in the earlier experiments. The present experiment was conducted one month after the first two experiments, so that we assumed that the effect of the earlier experiments were not remained.

4.2. Results and Discussion

The number of choices for mora-sized and syllable-sized units for ten Spanish stimuli shown in Table 3.

<table>
<thead>
<tr>
<th>materials</th>
<th>mora-sized</th>
<th>Syllable-sized</th>
<th>other</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish</td>
<td>0</td>
<td>97</td>
<td>3</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3. The distribution of mora-sized and syllable-sized choices for Spanish materials.

As can be seen from Table 3, the majority of the choice was syllable-sized. “Other” category included responses which failed to comply with the instruction.

The distribution of response types was submitted to a non-parametric Wilcoxon signed test. The Japanese–English bilingual subjects preferred syllable-sized choices to mora-sized choice, which was significantly different (Subject analysis: Z= -3.05, p<0.01; Item analysis: Z= -2.92, p< 0.01) - There was a significant difference between Japanese and Spanish materials for their preference ( $\chi^2$ =167.98, df = 1, p <0.001). This result clearly shows that they recognize syllables rather than morae for Spanish materials. In other words, this suggests that the bilingual children have syllables as a part of their metalinguistic knowledge and that their preference was also triggered by the Spanish materials.

5. Discussion

The present study has investigated whether Japanese-English bilingual children could be aware of both syllables and morae, presenting both native and foreign materials. As we have seen in the three experiments, they were sensitive to a mora-sized unit in Japanese, but a syllable-sized unit in English and Spanish.

The results in the present study have clearly shown that the bilinguals were aware of syllables as well as morae depending upon the input materials. Our earlier study has shown that the monolinguals were aware of morae regardless of input materials [14]. How can we account for this? This may be interpreted in the following way: the monolinguals mainly focus on the mora level within syllable structure regardless of input materials, while the bilinguals can focus on both syllable and mora levels depending upon the input materials. But why can the bilinguals access to the two levels, while monolinguals access to only the mora level regardless of the input materials?

As we have seen in section 1, our earlier studies revealed that the Japanese preschool children could be sensitive to the syllables as well as morae and that their sensitivity developed from syllables to morae due to the acquisition of morae or kana orthography [12]. Given the fact that the monolinguals access only to the mora level, they may be conditioned in such a way that they can no longer access to a higher level. Then, can they actually not access to the higher level? Our induction study has shown that the Japanese monolinguals actually could access to the syllable level very easily if we provide a sufficient training [14]. This fact may suggest that
Japanese monolinguals access to morae as a default, but they are ready to access to syllables if they are asked to do so. But in the case of the bilinguals, they are ready to access to both syllables and morae depending upon input materials. This may suggest that the bilinguals may have an ability to suppress the moraic consciousness if they hear non-native materials, although we still do not know what constitutes non-native inputs from the present study.

6. Conclusion
This study investigated the metalinguistic knowledge of the internal structure of syllables by Japanese-English bilingual children. The results showed that bilingual children could be aware of both syllables and morae, depending upon the input materials, suggesting that they may have a suppression mechanism.

7. Acknowledgement
This paper was a revised version of BA thesis written by the second author. This research was supported by Grant-in-Aid Scientific Research on Priority Areas by the Ministry of Education, Science, Sports and Culture: grant # is 10114216 which was given to the first author. We would like to thank Tatsuo Fuji and Toshihisa Senda of Japan Overseas Educational Services for the arrangement of the participants.

8. References