MORA VERSUS SYLLABLE: AN ANALYSIS OF NATIVE ENGLISH SPEAKERS' PRODUCTIONS FROM A JAPANESE LANGUAGE GAME

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INTRODUCTION

This paper will examine whether or not native English speakers recognize the reality of the linguistic unit known as a 'mora' found in Japanese (and other languages such as Tigrinya--see Bagemihl, 1988; Ito, 1988 --and some Bantu languages--see Hubbard 1995). This paper discusses data from native English-speaking children attempting to play a Japanese syllable insertion language game for the first time. This Japanese language game was also the focus of an investigation by Skaer (1991) and Haraguchi (1991). In their experiments Japanese speakers' production patterns were consistent with moraic segmentation. Since Japanese is a mora-based language, morae constrain the syllable structure. A mora is defined by Han (1962, in Hoequist 1985) as a unit equal to a short syllable. Ladefoged (1982: 226 in Vance 1987) states that "A mora is a unit of timing. Each mora takes about the same length of time to say" (p.62). In Japanese, all vowels (including those devoiced by phonological rule), geminate consonants, and the syllable-final /n/ are said to be moraic.[1] Since linguists generally define English as a syllable-based language, the theoretical question I ask is this: will these children interpret Japanese as a mora-based or syllable-based language?

Kubozono (1989) states that if standard syllable structure cannot express Japanese word production, the only way to account for speech behavior is to assume the mora as a relevant unit in the speech production of Japanese. If one defines the mora as an intermediate level between syllable and segment, vowel-consonant interaction such as CV-insertion can be described not as segmental, but as moraic productions. Kubozono also pointed out that "in English, there is reportedly a set of general constraints that hold between the peak and the coda, whereas constraints between the onset and the peak are relatively weak (cf. Fudge 1969, 1987). In Japanese, by contrast, co-occurrence restrictions operating between onset and peak are at least as strong as those holding between peak and coda." (p. 269) In other words, in English, there is a special association between the nucleus (peak) and the coda, which are said to form a constituent called the "rhyme." In Japanese, there is no special relationship between the nucleus and the coda. The association between the onset and nucleus is equally weak. The mora has therefore often been recognized as a relevant unit in phonological description. However, unlike a language such as English, the evidence of the Japanese mora suggests that there is no syllable unit 'rhyme' which is often implied to be a universal syllable constituent (see Ito 1988).[2] The present study found clear evidence of language transfer from the native language syllable structure in the

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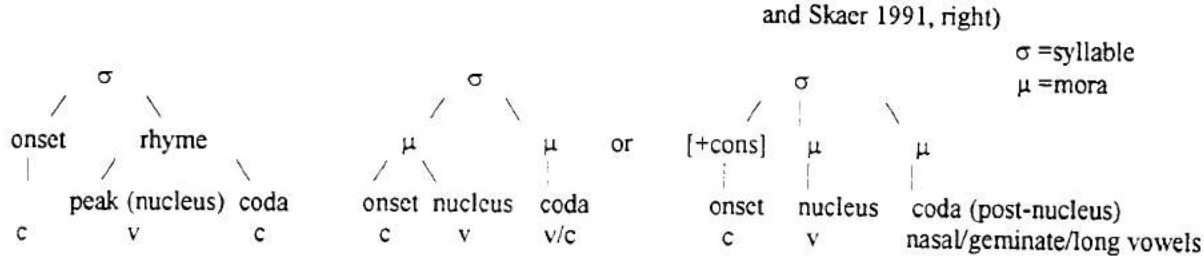
[1] In Japanese, morae are called *onsetsu* or *haku* by Kindaichi (1963 in Vance).

[2] **A.** Standard syllable structure (Ito 1988). **B.** Japanese syllable structure (Kubozono 1989, left and Skaer 1991, right)



production of game words. In terms of the relationship between production and perception results indicate that subjects have the ability to control productions and try to achieve perceptional distinctions in their language processing.

The Japanese language was chosen for this attempt because its phonological structure allows us to compare a child's sensibility at the syllabic level, which often suffices in English, to subsyllabic units such as certain types of morae in Japanese. The data will suggest some interesting strategies involving the metrical structure of Japanese. I was particularly interested in how special morae (the nasal /n/, geminate consonants, long vowels and diphthongs) were dealt with, i.e., whether the subjects treat them as morae. Not many linguists have dealt with the issue of syllable construction and morae within the exceptional phonology of language games, especially by child L2 learners.

This paper analyzes the data of child native English speakers playing the Japanese syllable insertion game "BABIBUBEBO" to see if they recognize the reality of the mora in Japanese. In experiments with adult native Japanese speakers, subjects treated a nasal /n/ (e.g. /riŋgo/ 'apple' or /mikan/ 'tangerine'); the first member of a geminate, as in /gakki/ 'instrument'; and the second of two long vowels (/ookii/ 'big') or diphthongs (/tokei/ 'clock') as morae (Kubozono 1989 and 1995; Skaer 1987 and 1991; Katada 1990; Poser 1990; Yoshida 1990; Otake and Hatano 1993; Han 1994; Broselow 1996), thus strongly supporting the notion that Japanese is a mora-based language. The question in this study is whether native English speakers recognize the nasal /n/, geminates, and long vowels or diphthongs as weight-bearing units in the prosodic structure of Japanese.[3]

This paper is organized into four major sections. First I will present the issue of whether or not the types of mora-timing units and syllable-timing units in this language game provide evidence for subsyllabic (mora) constituency. Second, I will explain my hypothesis and methodology. Third, I will analyze the speech production based on the data gathered. I will conclude by summarizing the major constructs of the theoretical approach developed here to account for the hierarchical prosodic structure of Japanese, which will show that the children's production conforms to a single theory of universal grammar, and that they generally recognize the Japanese-specific mora parameter.

THE BABIBUBEBO GAME[4]

The object of the language game in question is to insert a consonant-vowel sequence, "bV", after each mora of the cue word, where V is the same as the vowel of the preceding mora. Given the cue word /ki/ (tree), the game form is /kibi/. Likewise, given the cue word /ari/ (ants), the game form is /abaribi/. Moreover, the word /kao/ (face), which consists of a single syllable, is treated as two units, /ka/ and /o/ and the game form is /kabaobo/. The word /kaban/ (bag), which consists of two syllables, is treated as three units, /ka/, /ba/ and /n/ and the game form is /kabababambɯ/. In general, these words, outside of the game format, would be divided differently, depending on the phonetic system one was using, syllable or mora.

[3] The theory-internal prediction from another phonetic view point such as accent and tone would be another way to examine this issue.

[4] Children usually start playing the game around ten years old (reported to me by teachers and my friends), although Haraguchi (1991) mentioned that this game is played by mainly by junior or senior high school students in Japan.

(1)

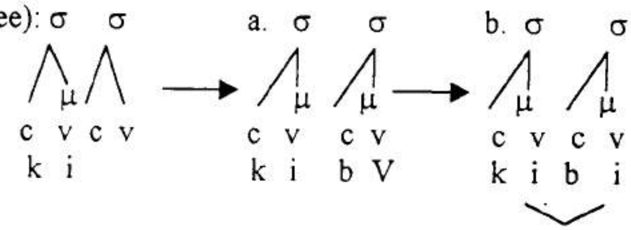
mora-based	vs	syllable-based	
a.ri		a.ri	"ants"
ka.o		kao	"face"
ka.ba.n		ka.ban	"bag"

The structure for the game is thus neither a syllable nor a segment, but a mora. A mora may have any of the three following realizations (adopted from Tsujimura 1996: 65):

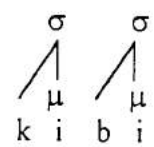
1. (C)V
2. the first part of a long consonant (or the first part of a geminate)
3. syllable final, or "moraic," nasal /n/

Rules of the game: a. Insert a syllabic skeleton bV after each mora.
b. Spread the preceding vowel to the free syllabic skeleton V.

For example, for the word *ki* (tree):



(2) one-mora: ki



"tree"

(3) two-mora: ari

"ants"

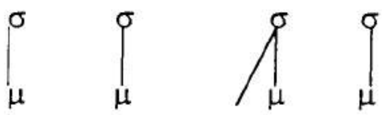
σ =syllable
μ =mora

(4) two-mora: kame

"turtle"

The word /ari/ is a two-mora word consisting of three segmental phonemes, while /kame/ is a two-mora word consisting of four segmental phonemes. From a moraic perspective, one heavy syllable (/a/ in /ari/) and two light syllables (/ka/ and /me/ in /kame/) should be equivalent fillings of a two-mora template, i.e., /a/ as a mora equals /ka/ as a mora. The simple CV-strings present no problems here; more interesting issues arise with examples containing postnuclear morae: a nasal /n/, geminates and long vowels or diphthongs. For long vowels and geminates there are exceptions to the mora-based account. In theory, /bV/ insertion after long vowels and geminates would be explained in a mora-based account. However, long vowels in postnuclear position behave differently (Skaer 1991): the second long vowel is [+cons], it would not be expected to allow insertion of an affix immediately following; long vowels do not allow 'bV' insertion, which is easily accountable within a framework involving the syllable.

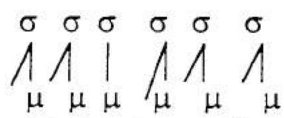
(5) e.g. /ookii/ "big" game word: /obokibi/ (syllable-based)



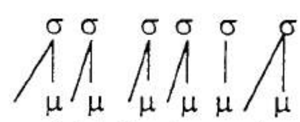
o **cv** o **v** k i **cv** i **v** v slot is empty.
bo [+cons] bi [+cons]

Japanese geminates are [+constricted glottal aspiration]. Japanese /p/, /t/, /k/ in the first part of a geminate are slightly aspirated, but not as strongly as their English counterparts (Vance 1987). Skaer (1991: 139) said, "some speakers systematically replace geminates with "tsu" for the orthographic symbol that indicates gemination (ッ)." This happened to two of my subjects (S3 and S4).

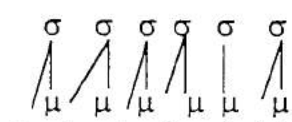
In general, a nasal /n/, geminates, and long vowels or diphthongs are all separate units, and constitute a mora by themselves. These morae could have an empty position. In the case of /n/, the V slot is empty.



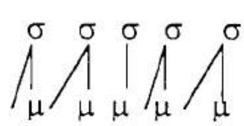
(6) nasal /n/ (medial) ri-ŋ-go r i b i m b ɯ g o b o "apple"



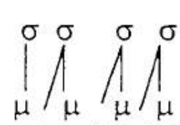
(7) nasal /n/ (final) mi-ka-n m i b i k a b a m b ɯ "tangeline"



(8) diphthong to-ke-i t o b o k e b e i b i "clock"



(9) geminate ga-k-ki g a b a k k i b i "instrument"



(10) long vowels o-o-k-i-i o b o k i b i "big"

Our game requires vowel spreading from the nuclear position into the unfilled slot of the inserted affix. Skaer (1991) claimed that since the moraic affix [bV] has no features specified, this violates prosodic licensing.[5] However, because the feature matrix is split into at least two tiers (see (11)), an affix [V] stands for [-cons], allowing for the spread of secondary features to an existing slot, thus avoiding a violation of prosodic licensing.[6] bV insertion with vowel feature spreading requires the recognition of nuclear melodies at the level of feature. As I stated on earier, the association between onset and nucleus is equally weak, making the Japanese syllable structure look like this (Skaer 1991 and 1994):

(11) Japanese Syllable Structure

Syllable tier:		σ	
Skeletal tier: (moraic timing units)		μ	μ
Feature Matrices tier:			
Primary Feature:	[+cons] (onset)	[-cons] (nucleus)	[+cons]
Secondary Features:	[αF]	[βF]	[χF]

This explains the situation of long vowels, which do not allow bV insertion because their second members are [+cons] in the nucleus position. In addition, it accounts for the differentiation between the mora and syllable in Japanese by saying that both syllable and morae are used in Japanese even though it is a mora-based language.[7] This Japanese syllable structure also explains the feature assimilation discussed later in this paper.

HYPOTHESIS AND METHODOLOGY

My hypothesis is that the subjects will treat Japanese as a mora-based language when confronted with a game word which lacks a nasal /n/ (especially in medial position), geminates, long vowels or diphthongs. However, because English is syllable-based, they will treat Japanese as syllable-based when dealing with game words which do exhibit these characteristics. Focusing the discussion on the relationship between syllable and mora within a single word, the possible

[5] Ito (1988 in Skaer 1991) said "prosodic licencing requires sequences of segments to conform to language universal and language specific syllabification principles, via epenthesis, spreading, or deletion, particularly in the cases where templates are either unfilled, or are not wholly filled." (p. 40)

[6] Skaer (1987) made a point "Recognition of the syllable tier allows stating the restructuring constraint in a much more elegant manner than a mora-based explanation affords." (p. 62)

[7] Skaer (1994) explains the Japanese metrical unit by mentioning "Constraint Theory": "…in any given string of consonants and vowels, there are theoretically many ways which the consonants and vowels can be grouped together to form larger prosodic units (such as moras or syllables)." (i.e. [cvc][vc] or [cv][cvc]) "However, in Constraint Theory for Japanese, …constraint builds minimal metrical units…this timing associates the timing tier to the primary feature tier of individual phonemes, via Ito's Universal Core Syllable Condition (UCSC)." (i.e. [cv][cv]c) "…Weight by Position, CV (produced by UCSC) must be attached to the preceding nuclear base-unit and given metrical weight, …" (p. 65)

production for /riŋgo/ "apple" might include the following: /ribimbɯgobo/, which would demonstrate that the student recognizes the status of the nasal /n/ as a mora in Japanese; /rimbigobo/, which would show that the student is putting /n/ in the coda and is not recognizing it as a mora; and /rimbɯgobo/, which would demonstrate that the student is putting /n/ in a coda, yet appears to be recognizing the syllabic status of /n/ in the choice of /bɯ/ rather than /bi/.

Subjects. The data were gathered from the speech of ten subjects, five boys and five girls, between the ages of 10 and 12. All are Japanese immersion fifth and sixth graders who started learning Japanese in a partial immersion program in the first grade. I chose students of the highest proficiency level based on my observation as a teacher in the class. None knew the purpose of the experiment, and none had had any prior experience with this game.

Methodology. The Babibubebo game was conducted by showing pictures of objects to the subjects. Instructions were given in both English and Japanese prior to the experiment. Subjects were given many examples until they realized the rules of this game. They were told to say the name of each picture first, in order to make sure that their production matched the original word. Then they were told to make a game word by combining the correct character /ba, bi, bɯ, be, bo/ in the following order: simple words as in (2)-(4), nasal /n/ as in (6)-(7), diphthongs as in (8), geminates as in (9), and long vowels as in (10) (see Appendix 1). Any mistakes were corrected during practice on the examples. There appears to be some variability in how BABIBUBEBO is played, i.e. whether or not a /bV/ syllable is inserted. In my experience in Japan, a syllable is inserted after /n/. Haraguchi (1991) also shows insertion of a syllable after /n/. However, Skaer (1991) does not show insertion after /n/. When demonstrating the game, I inserted a syllable after /n/. Haraguchi (1991: 50) mentioned that "This word-game is based on the spelling pronunciation of Japanese words as written in Kana syllabicity." In the actual experiment, however, the subjects saw only a picture, but not the written word (or script) to avoid the orthographical effect, especially for words containing geminate consonants. They were also asked to say the game word at a fast speed to avoid the careful production caused by knowledge of the orthographical character. Skaer (1994) mentioned that "Careful speech treats each mora independently, and demonstrates a direct one-to-one correlation between the words as they are presented graphically in writing, rather than as a product of prosodic (speech) production." (p. 81) Each subject made one recording of 20 words which had no nasal /n/, geminates, long vowels or diphthongs; 36 which had a medial nasal /n/; 28 which ended with a final nasal /n/; 17 diphthongs; 21 geminates; and 20 long vowels. Since geminates in foreign words such as /attakkɯ/ "attack" and /mikkɯsɯ/ "mix" may cause acoustic problems according to Kitahara (1996) [8], I eliminated them from my list. I tried to create a natural environment for the subjects by using the familiar flash card approach and taping them in the classroom. However, after I tested the words, I noticed that the geminates and long vowels are problematic for this experiment. As I stated before, the geminates and long vowels act differently by not following a purely mora-based account, but a syllable-based one. For the purpose of this experiment, I eliminated them from my data.

I analyzed each production carefully to determine whether or not they relied on syllable-constituency. There were some unrelated speech errors (e.g., metathesis, deletion), which were deliberately excluded from the data (see Appendix 2). These speech errors would require another

[8] "...there is a significant relation between the default accentuation (McCawley 1968) and CG (consonant gemination). ...CG is absent in the lexicon but present in the output." (Kitahara 1996 p. 62)

investigation, which is beyond the scope of this paper (for discussion of common speech errors in Japanese, see Kubozono (1989) and for discussion of "slips of tongue", see Jaeger (1991)).

RESULTS

The investigation demonstrates the various ways in which the game system is dependent on the prosodic structure of Japanese. The following paragraphs discuss the production of game words containing the segments of interest, nasal /n/ and diphthongs.

Differentiation of nasal /n/. There are four possible production results for words with moraic /n/. I demonstrate these types with the word *ringo* "apple":

Type A: ri bi m bɯ go bo (well-formed)

Type B: **rim** bɯ go bo (syllable with default vowel "ɯ")

Type C: **rim bi** go bo (syllable with spreading from preceding vowel)

Type D: **rim bo** go bo (syllable with spreading from following vowel)

Type A is mora-based (a well-formed production). Type B is syllable-based with evidence of some awareness of the moraic status of /n/ in the choice of /b + default vowel ɯ/ rather than /b + preceding vowel/ after a nasal /n/; but it still treats the nasal /n/ as a part of a syllable by producing /rim/ for the example *ringo* "apple" /**ribimb**ɯgobo/. Type C is syllable-based with the insertion of /b+ preceding vowel/ and placement of /n/ in the coda by producing /rim/. Type D is syllable-based, and is a similar phenomenon to Type C except that spreading occurs from the following vowel instead of the preceding vowel. The choice of the default vowel /ɯ/ reflects the spreading of the empty nucleus in the /n/ mora. Kaye calls /ɯ/ the "cold" vowel [9], which he defines as a vowel with no salient features (Kaye 1990, in Yoshida 1990). This follows the universal "Coda Licensing Principle" identified by Kaye (1990 in Yoshida 1990): Post-nuclear rhymal positions must be licensed by a following onset. This principle says that you cannot have two onsets in a row (*OROO). Regarding the example *ringo,* the issue is whether /n/ is in the onset or the rhyme within its mora. According to the Coda Licensing Principle, /n/ must be in the rhyme, licensed by /g/. Otherwise /ŋg/ would be two onsets together, which is illegal. The spreading from the following /o/ can be interpreted as evidence of the licensing relationship between the onset /g/ and /ŋ/ in the coda position.

Medial nasal /n/. The examples of medial nasal /n/ are found in table 1.

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[9] The cold vowel is high, back, unrounded vowel [ɯ], since [+round] is the salient feature of U^0. (see Kaye in Yoshida 1990)

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OROR                         OROROR                  O=onset R=ryhme N=nucleus
| | ||                       | | | | | |
|/N|/N (empty nucleus)       |/N |/ N |/N
h o  n  "book"               r i n V°g o  "apple"
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Table 1. Four types of possible productions

	Type A	Type B	Type C [10]	Type D
riŋgo "apple"	ribimbɯgobo	rimbɯgobo	ri(bi)mbigobo	ri(bi)mbogobo
oŋgakɯ "music"	obombɯgabakɯbɯ	ombɯgabakɯbɯ	o(bo)mbogabakɯbɯ	o(bo)mbagabakɯbɯ
sennɯki "can	ebembɯnɯbɯkibi	sembɯnɯbɯkibi	se(be)mbenɯbɯkibi	se(be)mbɯnɯbɯkibi

As shown in table 2 below, the subjects followed a mora-based structure in most cases.

Table 2. The number of productions

	Type A	Type B	Type C	Type D	Other	Total
Number of tokens	238	13	24	13	72	360
Percentage	66%	4%	7%	4%	22%	103%[11]

Table 3. The number of non-mora-based productions

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Total
Non Mora-based	14	4	18	14	15	12	5	16	12	12	122/360
Percentage	39%	10%	50%	39%	42%	33%	14%	44%	33%	33%	34%

There is evidence of some universal constraints, i.e., the OCP (Obligatory Contour Principle) and nasal place assimilation. The subjects were affected by words starting with either a vowel or a [+voice] consonant such as *ongaku* "music" and *renkon* "lotus root" (*[+voice][+voice] in /**obo**/ and /**rebe**/, See Appendix 1.). Most of the Type C productions involved bilabial consonants preceding the nasal /m/ such as *tonbo* "drgon fly" and *tanpopo* "dandelion" (labial assimilation: fronting). Most of the productions of Type D involved velar consonants preceding the nasal /ŋ/ such as *ongaku* and *sanko* "three (objects)" (velar assimilation: backing). Tsujimura (1996) mentioned that "/n/ is realized as the nasal sound that shares the same place of articulation as the immediately following consonant" (p.30). This explains Type D productions, in which the vowel from the following CV spreads, while Type C labial assimilation came from fronting in which the vowel from the preceding CV spreads. Again in Japanese syllable structure, according to Skaer (1991, 1994), insertion requires the recognition of nuclear melodies, the vowel feature spreading mentioned earlier. That is, vowel spreading in this sense occurs either rightward or leftward depending on the type of feature place assimilation (i.e. fronting or backing), and does not violate prosodic licensing in the secondary feature level of the feature matrics tier (see figure (11)).

Interestingly, there was less coronal assimilation than other forms of place assimilation. The subjects' recognition of the coronal nasal /n/ was somehow very clear. Paradis and Prunet (1991 p. 2) state that "...coronals are the only consonants to be invisible to phonological processes such as deletion in Japanese" (see Grignon 1984: 324). The result, however, is against their claim that "coronal harmonies are much more frequent than other harmonies" (coronal underspecification).

Final nasal /n/. In the test words for final nasal /n/, because there is no syllable following /n/, productions of Type D were impossible. The examples are found in Table 4.

[10] S3 and S4 could say /ribi/ instead of /rin/ for example.

[11] Totals in the data do not always add up to 100 due to numerical rounding.

Table 4. Three types of possible productions

	Type A	Type B	Type C
hon "book"	hobombɯ	hombɯ	hombo
kirin "girraff"	kibiribimbɯ	kibirimbɯ	kibirimbi

As shown in Table 5 below, the subjects treated final nasal /n/ as a mora in 92% cases. No subjects treated /n/ as Type B, but Type C. Following the Coda Licensing Principle, since the final nucleus cannot license the preceding onset to dominate a segment, there is an empty onset position in the structure (see note 9). In this case, although the subjects preferred Type C to Type B, they realized the onset/rhyme pattern by inserting [bV] in this position correctly, not treating /n/ as a part of the onset.

Table 5. The number of productions

	Type A	Type B	Type C	Other	Total
Number of tokens	258	0	13	9	280
Percentage	92%	0%	5%	3%	100%

Table 6. The number of non-mora-based productions

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Total
Number of tokens	0	1	5	2	5	0	2	5	1	1	22/280
Percentage	0%	4%	18%	7%	18%	0%	7%	18%	4%	4%	8%

Some speech errors such as /gonibiimbi/ for /gonin/ "five" reflect language-specific constraints, while others, such as final nasal deletion may come from universal constraints. The former case shows that some subjects treated the second vowel of /ii/ as a mora, demonstrating an OCP violation, instead of treating it as a long vowel. Yoshida's (1990) claim for "nuclear fusion" says that "...there exists a process in which two successive nuclear constituents are fused into one by the application of the OCP." (p. 344) The other possibility is that the subject simply treated /in/ as a syllable through a slip of the tongue: goni + in. The latter case shows that they deleted a coronal /n/ by coronal underspecification, supporting Paradis and Prunet's (1991) assertion (see Appendix 2).

Diphthongs. There are four different types of production for diphthongs. I demonstrate these types with the word *suika* "watermelon":

Type A: sɯ bɯ **i bi** ka ba (well-formed)

Type B: sɯi bi ka ba (syllable with spreading from the second member of diphthong)

Type C: sɯi bɯ ka ba (syllable with spreading from preceding vowel)

Type D: sɯ bɯ ka ba (syllable/deletion)

Type A is mora-based (a well-formed production). Type B is syllable-based with evidence of mora structure indicated by inserting /b + the second member of diphthong/, while still treating the second member of the diphthong as a part of a syllable by producing /sɯi/ for the example "watermelon" (/sɯibikaba/ instead of the well-formed /sɯ**bɯibi**kaba/). Type C is syllable-based, as indicated by the insertion of /b + the preceding vowel of first CV-string/ and also the production of /sɯi/, thus treating the second segment of the diphthong as a part of the syllable. Type D is syllable-based, as indicated by deletion of the second member of the diphthong, insertion of /b + the preceding vowel/, and production of /sɯi/ before the deletion, treating the second member of the diphthong as a part of syllable. The examples of diphthongs are found in Table 7.

Table 7. The types of possible productions

	Type A	Type B	Type C	Type D
tokei "clock"	tobokebeibi	tobokeibi	tobokeibe	tobokebe
sɯika "watermelon"	sɯbɯibikaba	sɯibikaba	sɯibɯkaba	sɯbɯkaba

Table 8. The number of productions of diphthongs

	Type A	Type B	Type C	Type D	Other	Total
Number of tokens	121	10	1	14	24	170
Percentage	71%	6%	0.6%	8%	14 %	99.6%

Table 9. The number of non-mora-based productions

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Total
Number of tokens	6	8	3	3	6	3	3	7	9	1	49 / 170
Percentage	35%	47%	18%	18%	35%	18%	18%	41%	53%	6%	29%

The mora status of diphthong segments is clearer in the data. Type D (8%) follows a universal constraint by deleting the Japanese default vowel [ɯ] of [aɯ] in most cases (e.g. taɯn see Appendix 1): There is vowel assimilation into the preceding vowel (the first member of the diphthong). This language-particular default vowel expresses the radical underspecification theory stated by Archangeli (1988): "Radical Underspecification treats feature specifications as the phonological primitives of a language and it encodes markedness of various systems by the use each makes of Universal Default Rules vs. language-particular default rules." (p. 198) On the contrary, Type B shows that recognition of the second member of diphthongs as a mora is strong, especially in combinations which do not include the default vowel [ɯ] (i.e. [ai], [ei] and [ao]).

DISCUSSION AND CONCLUSION

In this paper, I explored the constituency subjects' productions in a Japanese syllable insertion game, mora versus syllable. The results show evidence of the influence of universal principles such as the OCP and assimilation as well as language-specific parameters (e.g. the mora parameter). The experiment data presented in the preceding section show that the subjects exhibited a remarkable difference in their preferred pattern of segmental game productions. They preferred to use a parameter setting from NL knowledge (syllable-based) when the word was somehow constrained by universal grammar (e.g. OCP *[+voice][+voice], default setting [ɯ]). This language game requires detailed monitoring, mora by mora, by using a parameter setting in the universal principle.

The domain of CV-string is the syllable though the metrical unit is the mora. Thus both the mora and the syllable are relevant units in Japanese phonology. The motivation for the concept of the mora was proven as a consequence of analyzing sequences of nasal /n/ and diphthongs in this paper. Yoshida (1990: 334) pointed out that " ...if a given string cannot be analyzed as forming a single syllable within a theory of a syllable structure then the same theory should be responsible for explicitly indicating the syllable boundary." I therefore take his claim for the mora parameter in the subjects' perspective of this language game. This also refers to Skaer's claim of "Constraint Theory", which builds minimal metrical units (morae or syllables) in the same theory (see Skaer 1994).

The theoretical questions discussed include: Is it the case that the subjects are initially sensitive to any rhythmic unit? Type B in medial nasal /n/ such as /rimbɯgobo/ showed some sensitivity, while at the same time using the English template treating /rim/ for /ribimbɯgobo/ "apple" as part of a syllable, but not a mora. They accepted Japanese as mora-based in most cases, as shown in the previous section. More specifically, they treated segments such as nasal /n/ and diphthongs as extra-moraic. They used some kind of universal unit of representation, from which they specified the characteristics of the unit of their native language, as the Type C syllable-based nasals. Their native language syllable template determined the way they perceived these units in Japanese at the interlanguage level. If speakers of different language backgrounds control timing differently, language-specific timing rules are needed. These findings are also important from the viewpoint of linguistic theory, such as the fact that certain features of Japanese timing organization for CVCV are governed by "universal rules," as claimed by Chomsky and Halle (1968: 295). Universal models, however, will not account for the entire picture of Japanese timing structure as presented in the previous section.

The structure required for this game is again neither a syllable nor a segment, but a mora. Only the moraic system can consistently explain the way in which the game is processed by native Japanese speakers. The unit should be understood as a mora associated with a nucleus and an onset if there is one. Japanese requires two hierarchical levels of language processing, first the segment and second the word. The subjects clearly identified the need for language-specific implementation rules for speech timing as well as speech production. The following issues were examined in the data: (1) the elasticity of segment productions and (2) the similarity in word productions among words with the same number of morae but with different segmental compositions: /ari/ 'ants' (two mora and one syllable) vs /kame/ 'turtle' (two mora and two syllable).

Under the approach of metrical theory, epenthesis in Japanese is simply the insertion of an empty vowel slot whose features are filled in by the general redundancy rules of this language: a strict CV language. As the rules have the potential to apply in each component of phonology, it is predicted that the epenthetic vowel will be the same regardless of whether insertion takes place in the language game or the NL phonology: it is still a CV-word. The results of this experiment indicate that, acoustically, morae are essential units operating at a certain point in Japanese grammars.

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Appendix 1: Game Words

Simple words		
Non-game word	**Gloss**	**Game Word**
e	picture	ebe
ki	tree	kibi
me	eye	mebe
momo	peach	mobomobo
ari	ants	abaribi
inɯ	dog	ibinɯbɯ
isɯ	chair	ibisɯbɯ
ɯma	horse	ɯbɯmaba
kame	turtle	kabamebe
kɯma	bear	kɯbɯmaba
neko	cat	nebekobo
atama	head	abatabamaba
ahirɯ	duck	abahibirɯbɯ
sakɯra	cherry blossoms	sabakɯbɯraba
tamago	egg	tabamabagobo
hasami	scissors	habasabamibi
nezɯmi	mouse	nebezɯbɯmibi
inošiši	wild boar	ibinobošibišibi
niwatori	chicken	nibiwabatoboribi
monosaši	ruler	mobonobosabašibi
Total 20		

Medial Nasals							
Non-game word	**Gloss**	**Game Word**	**A**	**B**	**C**	**D**	**Other**
riŋgo	apple	ribimbɯgo	7			2	1
tombo	dragon fly	tobombɯbobo	5		4		1
denwa	telephone	debembɯwaba	8				2
kiŋgyo	gold fish	kibimbɯgyobo	5	1			4
empitsɯ	pencil	ebembɯpibitsɯbɯ	5	3			2
sansɯɯ	math	sabambɯsɯbɯɯbɯ	9				1
nihoŋgo	Japanese	nibihobombɯgobo	8				2
ensokɯ	field trip	ebembɯsobokɯbɯ	5		1	1	3
oŋgakɯ	music	obombɯgabakɯbɯ	5			2	3
ninjin	carrot	nibimbɯjibimbɯ	6	3			1
reŋkon	lotus root	rebembɯkobombɯ	5			2	3
sensei	teacher	sebembɯsebeibi	10				
tampopo	dandelion	tabambɯpobopobo	6		2		2
sennɯki	bottle opener	sebembɯnɯbɯkibi	7				3
entotsɯ	chimney	ebembɯtobotsɯbɯ	7				3
šiŋgoɯ	traffic lights	šibimbɯgoboɯbɯ	7			1	2
sempɯɯki	fun	sebembɯpɯbɯɯbɯkibi	5				5
sentakɯki	washing machine	sebembɯtabakɯbɯkibi	7				3
šiŋkansen	Shinkansen	šibimbɯkabambɯsebembɯ	5		2		3

Medial Nasals							
Non-game word	**Gloss**	**Game Word**	**A**	**B**	**C**	**D**	**Other**
onnanoko	girl	obombɯnabanobokobo	5			1	4
konničiwa	hello	kobombɯnibičibiwaba	8				2
saŋko	three (number for things)	sabambɯkobo	2	1	3	2	
yoŋko	four (objects)	yobombɯkobo	6			2	2
sambiki	three (animals)	sabambɯbibikibi	7		3		
yoɴhiki	four (animals)	yobombɯhibikibi	5		2		3
sambon	three (long objects)	sabambɯbobombɯ	9				1
yoɴhon	four (long objects)	yobombɯhobombɯ	5		2		3
sammai	three (paper)	sabambɯmabaibi	9				1
yommai	four (paper)	yobombɯmabaibi	2	1	3		4
panda	panda	pabambɯdaba	10				
inči	inch	ibimbɯčIbi	4	2	2		2
rampɯ	ramp	rabambɯpɯbɯ	5	2			3
torampɯ	trump	toborabambɯpɯbɯ	9				1
rondon	London	robombɯdobombɯ	8				2
Total 34							

Final Nasals						
Non-game word	**Gloss**	**Game Word**	**A**	**B**	**C**	**Other**
hon	book	hobombɯ	9		1	
kirin	giraffe	kibirmbinbɯ	10			
mikan	tangerine	mibikabambɯ	10			
kaban	bag	kababababambɯ	10			
yakan	kettle	yabakabambɯ	10			
šašin	picture	šabašibimbɯ	10			
sannin	three (people)	sabambɯnibimbɯ	10			
sanbon	three (long objects)	sabambɯbobombɯ	9		1	
yonhon	four (long objects)	yobombɯhobombɯ	8		2	
roppon	six (long objects)	roboppobombɯ	9			1
gonin	five (people)	gobonibimbɯ	7		1	2
sekken	soap	sebekkebembɯ	10			
ninjin	carrot	nibimbɯjibimbɯ	10			
šinkansen	Shinkansen (bullet train)	šibimbɯkabambɯsebembɯ	9		1	
ohirɯgohan	lunch	obohibirɯbɯgobohabambɯ	10			
yasɯmijikan	recess	yabasɯbɯmibijibikabambɯ	10			
otoosan	father	obotobosabambɯ	8		2	
okaasan	mother	obokabasabambɯ	7		2	1
ojiisan	grandfather	obojibisabambɯ	10			

Final Nasals						
Non-game word	**Gloss**	**Game Word**	**A**	**B**	**C**	**Other**
ojisan	uncle	obojibisabambɯ	10			
obaasan	grandmother	obobabasabambɯ	8		1	1
obasan	aunt	obobabasabambɯ	10			
oniisan	brother	obonibisabambɯ	9			1
oneesan	sister	obonebesabambɯ	10			
pan	bread	pabambɯ	10			
raion	lion	rabaibiobombɯ	8			2
raamen	noodle	rabamebembɯ	10			
rondon	London	robombɯdobombɯ	7		2	1
Total 28						

Diphthongs							
Non-game word	**Gloss**	**Game Word**	**A**	**B**	**C**	**D**	**Other**
saikoro	dice	sabaibikoborobo	7	2			1
boɯši	ball	boboɯbɯšibi	8	1			1
bɯdoɯ	grape	bɯbɯdoboɯbɯ	8				2
tokei	clock	tobokebeibi	10				
šimaɯma	zebra	šibimabaɯbɯmaba	5			2	3
reizoɯko	refrigerator	rebeibizoboɯbɯkobo	2	3			5
omoi	heavy	obomoboibi	7			2	1
karɯi	light	kabarɯbɯibi	7				3
sɯika	water melon	sɯbɯibikaba	7			2	1
rajio	radio	rabajibiobo	10				
naifɯ	knife	nabaibifɯbɯ	10				
piano	piano	pibiabanobo	10				
taorɯ	towel	tabaoborɯbɯ	7	3			
raion	lion	rabaibiobombɯ	9			1	
taɯn	town	tabaɯbɯmbɯ	6			3	1
gaɯn	gown	gabaɯbɯmbɯ	5			3	2
paɯndo	pound	pabaɯbɯmbɯdobo	3	1	1	1	4
Total 17							

Geminates		
Non-game word	Gloss	Game Word
rappa	trumpet	rabappaba
ippiki	one (animals)	ibippibikibi
roppiki	six (animals)	roboppibikibi
roppon	six (long objects)	roboppobonbɯ
šippo	tail	šibippobo
hoppeta	cheek	hoboppebetaba
roppyakɯ	six hundreds	roboppyabakɯbɯ
kippɯ	ticket	kibippɯbɯ
teppen	top	tebeppebenbɯ
happa	leaf	habappaba
nippon	Japan	nibippobombɯ
ippai	many	ibippabaibi
kitte	stamp	kibittebe
mittɯ	three (number for things)	mibittɯbɯ
čotto	a little	čobottobo
sekken	soap	sebekkebembɯ
ikko	one (number for things)	ibikkobo
rokko	six (number for things)	robokkobo
gakkoo	school	gabakkobo
gakki	instrument	gabakkibi
bikkɯri	surprise	bibikkɯbɯribi
Total 21		

Long Vowels		
Non-game word	**Gloss**	**Game Word**
ooi	many	oboibi
ookii	big	obokibi
čiisai	small	čibisabaibi
koori	ice	koboribi
tooi	far	toboibi
jɯɯkɯ	nineteen	jɯbɯkɯbɯ
taiiku	gym	tabaibikɯbɯ
iie	no	ibiebe
ɯrešii	happy	ɯbɯrebešibi
kanašii	sad	kabanabašibi
nooto	notebook	nobotobo
boorɯ	ball	boborɯbɯ
koohii	coffee	kobohibi
piinattɯ	peanut	pibinabattɯbɯ
otoosan	father	obotobosabambɯ
okaasan	mother	obokabasabambɯ
ojiisan	grandfather	obojibisabambɯ
obaasan	grandmother	obobabasabambɯ
oniisan	brother	obonibisabambɯ
oneesan	sister	obonebesabambɯ
Total 20		

Although originally part of the stimulus materials, the geminates and long vowels were excluded from the data results as they proved to be especially problematic.

Appendix 2: Speech Errors

Metathesis	**Gloss**	**Game Words**	**Errors**
karɯi	light	kabarɯbɯibi	kabaibirɯbɯ
inči	inch	ibimbɯčibi	ibičibinɯ
riŋgo	apple	ribimbɯgobo	ribigobombɯ
taorɯ	towel	tabaoborɯbɯ	tabarɯbɯobo
Deletion	**Gloss**	**Game Words**	**Errors**
nippon	Japan	nibipobombɯ	nibipobo
raion	lion	labaibiobombɯ	labaibiobo
šiŋgoɯ	traffic lights	šibimbɯgoboɯbɯ	šibimbɯgobo
ippai	many	ibipabaibi	ibipaba
Others	**Gloss**	**Game Words**	**Errors**
gonin	five (number for people)	gobonibimbɯ	gobonibiimbi
gakkoo	school	gabakobo	gabakoboɯmbɯ
rappa	trumpet	rabapaba	rabatsubaɯbapaba
ippai	many	ibipabaibi	ibipaaibi
hoppeta	cheek	hobopebetaba	hobopebetabaaba