Lyman's Law Effect in Japanese Sequential Voicing: Questionnaire-Based Nonword Experiments*

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Abstract

The present study investigated Lyman's Law effect (OCP) in Japanese sequential voicing by two questionnaire-based experiments using nonexistent compounds. Experiment 1 explored the positional effect of the voiced obstruent contained in the second element. Experiment 2 investigated the influence of etymological type of lexical stratification of the first element. The change in results of these experiments for a period of twenty-one years was also examined. It may be concluded from this research that (1) Lyman's Law is a general tendency rather than a categorical prohibition, (2) the etymological type of the first element affects Japanese sequential voicing, and (3) the 'X-basigo' exception, where X represents any first element, has closely conformed to the tenets of Lyman's Law over twenty-one years.

Keywords: sequential voicing Lyman's Law OCP questionnaire decision tree analysis

0. Introduction

Sequential voicing in Japanese, or *rendaku*, refers to voicing of the initial voiceless obstruent of a second element in a compound. Lyman's Law is a well-known condition inhibiting *rendaku* when the second element of the compound already contains a voiced obstruent. Lyman's Law is one particular case of Obligatory Contour Principle (OCP) by which an identical element or feature is prohibited from repeating within a certain domain. In order to explore *rendaku* ruled by Lyman's Law, two experiments were conducted in the present study. Experiment 1 explored how the position and distance of the voiced obstruent contained in the second element affect

rendaku. Experiment 2 investigated how the etymological type of the lexical stratification of the first element influences *rendaku* in exceptional cases to Lyman's Law. Etymological types of lexical stratification of Japanese are generally classified into native Japanese, Sino-Japanese (Chinese Borrowing), and foreign loanwords. It has been well-documented and is uncontroversial that the etymological type of second elements affects *rendaku*. *Rendaku* occurs more frequently in cases that the second element is native Japanese, whereas it less frequently or hardly ever occurs where the second element is Sino-Japanese or foreign loanwords. In previous studies (Vance 1979, Ito and Meter 2003: 147), it is concluded that the etymological type of the second element affects *rendaku*, but that the first element has no effect on *rendaku* voicing of the second element. Another aim of this study is to investigate the change in results of these experiments over a period of twenty-one years. These experiments were conducted in 1984 by Murata and in 2005 by Ihara with an interval of twenty-one years based on the questions used in (Murata 1984) by simply asking for a single choice out of each pair of voiceless and voiced nonexistent compound words. These experiments were questionnaire-based. Vance (1979) originally applied a questionnaire-based approach to the research of *rendaku*. His experiment was run with too small sample size (14 participants) for a statistical investigation and too many test items for participants to process (645 items.) The test items used were hybrid compounds consisted of a modern Japanese word and an old Japanese word. (Murata 1984) and (Murata and Ihara 2006) expanded the sample size and employed carefully selected and elaborated test items for the specific phenomena of *rendaku*. The present study focuses on the experimental findings rather than theoretical considerations.

1. Sequential Voicing (*Rendaku*)

In the Japanese language, when two words are compounded, the initial voiceless consonant of the second element is voiced, which does not always occur consistently.

(1) a. ko 'small' + taiko 'drum' → ko-daiko / *ko-taiko 'small drum'
b. oo 'big' + hako 'box' → oo-bako / *oo-hako 'big box'

For example, in (1a), where the first element /ko/ 'small' and the second element /taiko/ 'drum' are compounded, the initial voiceless obstruent /t/ of the second element /taiko/ is voiced as /d/ as in /ko-daiko/ 'small drum.' This is the phenomenon called *rendaku*.

In Japanese, /h/ behaves like an obstruent whose voiced counterpart is /b/. In (1b), /oo/ 'big' and /hako/ 'box' are compounded to be /oo-bako/ 'big box.' The voiceless /h/ alternates with the voiced /b/, because the modern Japanese /h/ was derived from /p/ via a voiceless bilabial fricative through historical change (Hashimoto 1950, Komatsu 1981, Vance 1979).

2. Lyman's Law

Lyman's Law is a well-known condition on *rendaku* that the existence of a voiced obstruent in a second element prohibits *rendaku*.

(2) a. tori 'bird' + kago 'cage' → tori-kago/ *tori-gago 'birdcage'
b. naga 'long' + sode 'sleeve' → naga-sode/ *naga-zode
'long sleeve'
c. oo 'big' + tokage 'lizard' → oo-tokage/ *oo-dokage 'big lizard'
d. nawa 'rope' + hasigo 'ladder' → *nawa-hasigo/ nawa-basigo
'rope ladder'

In (2a), the second element /kago/, which contains a voiced obstruent, does not undergo voicing. The compounded word is not /*tori-gago/ but /tori-cago/. *Rendaku* is prohibited.

(3) a. 2nd element of (2a) b. 2nd element of (2b)

k a	g o	t o	k a	g e
C_1V	C_2V	C_1V	C_2V	C_3V

Lyman's Law is one particular case of Obligatory Contour Principle (OCP) by which an identical element or feature is prohibited from repeating within a certain domain (Ito & Mester 1986, 2003; Kubozono 1999, 2005). The relevant feature here is laryngeal [+voice, -sonorant] and the domain is the second element of a compound. In (2a-b), C_2 in the two-mora CVCV-structured second element is a voiced obstruent, and in (2c-d), C_3 contained in the three-mora CVCVCV-structured second element is a voiced obstruent. C_1 is a potential *rendaku* site. In (2a-b), C_2 is adjacent to the potential *rendaku* site C_1. In (2c-d), C_3 is at a distance from C_1 by the intervention of C_2. The intervening V is irrelevant here. (2d) /nawa-basigo/ is one of the few exceptions to

Lyman's Law found in the existing vocabulary. The second element /hasigo/ contains a voiced obstruent C_3. Nevertheless, it undergoes *rendaku*.

3. Experiment 1

Experiment 1 explored how the position and distance of the voiced obstruent contained in the second element affect *rendaku*.

3.1. Method

The experiments were conducted with a total of 256 undergraduate students of St.Marianna University School of Medicine, Tokyo Institute of Technology, and Nihon University in 2005, and 194 students of Kyushu Institute of Technology and Yamaguchi University in 1984. All participants were native speakers of Japanese. However, analyses were carried out depending on the number of participants who responded to each item due to missing values.

The second elements of two-element compounds were controlled by varying the positions of the voiced obstruent. The position of the voiced obstruent was varied from the second mora position to the fourth mora position (C_2, C_3, C_4). The participants were asked to judge whether or not the first obstruent of these second elements is voiced in each question as exemplified in (4). These voiced-and-voiceless paired questions were randomly presented to participants in a single questionnaire.

(4) Voiced-and-voiceless paired question

□ 長(ナガ)・タギ (/naga-tagi/)

□ 長(ナガ)・ダギ (/naga-dagi/)

3.2. Stimulus Items and Item-by-Item Analyses

As shown in Table 1, two real words /naga/ 'long' and /oo/ 'big' were chosen as the first elements. The two-mora CVCV-structured nonword /tagi/, the three-mora CVCVCV-structured nonword /harage/, and the four morae CVCVCVCV-structured nonword /haranige/ were chosen as second elements to measure *rendaku*. C_2 was a voiced obstruent in /tagi/, C_3, in /harage/, and C_4, in /haranige/. This manipulation was intended to keep the second element semantically neutral or avoid analogy and to make

the experiments easier to control.

Table 1. Experiment 1 in 1984

1st element + 2nd element	1984 Voiced	1984 Voiceless	1984 Rate	Chi-square test of goodness-of-fit
(1) CVCV-structured 2nd element				
naga-tagi / naga-dagi	16	177	0.08	$\chi^2(1)=134.31, p<.001$
oo-tagi / oo-dagi	30	164	0.15	$\chi^2(1)=92.56, p<.001$
(2) CVCVCV-structured 2nd element				
naga-haragi / naga-baragi	88	110	0.44	$\chi^2(1)=2.44, p=.12$, *n.s.*
oo-haragi / oo-baragi	75	122	0.38	$\chi^2(1)=11.21, p<.001$
(3) CVCVCVCV-structured 2nd element				
naga-haranige / naga-baranige	55	80	0.41	$\chi^2(1)=4.63, p<.05$
oo-haranige / oo-baranige	52	83	0.39	$\chi^2(1)=7.12, p<.01$

Table 2. Experiment 1 in 2005

1st element + 2nd element	2005 Voiced	2005 Voiceless	2005 Rate	Chi-square test of goodness-of-fit
(1) CVCV-structured 2nd element				
naga-tagi / naga-dagi	43	214	0.17	$\chi^2(1)=113.78, p<.001$
oo-tagi / oo-dagi	48	208	0.19	$\chi^2(1)=100.00, p<.001$
(2) CVCVCV-structured 2nd element				
naga-haragi / naga-baragi	71	182	0.28	$\chi^2(1)=48.70, p<.001$
oo-haragi / oo-baragi	71	184	0.28	$\chi^2(1)=50.07, p<.001$
(3) CVCVCVCV-structured 2nd element				
naga-haranige / naga-baranige	74	182	0.29	$\chi^2(1)=45.56, p<.001$
oo-haranige / oo-baranige	57	111	0.34	$\chi^2(1)=17.36, p<.001$

In Table 1 and 2, compound words are examined by a series of chi-square tests of goodness-of-fit setting an expected value of equal frequency (50% random chance) for choice of a voiceless or voiced initial consonant in the second element. Table 1 and Table 2 show that a significantly larger proportion of participants selected the voiceless case for almost all stimulus items.

Table 3. Comparison of 1984 and 2005 in Experiment 1

1st element + 2nd element	*Rendaku* rate 1984	*Rendaku* rate 2005	Chi-square test of independence
(1) CVCV-structured 2nd element			
naga-tagi / naga-dagi	0.08	0.17	χ^2 (1)=6.894, p <.01
oo-tagi / oo-dagi	0.15	0.19	χ^2 (1)=0.832, p =.362, *n.s.*
(2) CVCVCV-structured 2nd element			
naga-haragi / naga-baragi	0.44	0.28	χ^2 (1)=13.058, p <.001
oo-haragi / oo-baragi	0.38	0.28	χ^2 (1)=5.317, p <.05
(3) CVCVCVCV-structured 2nd element			
naga-haranige / naga-baranige	0.41	0.29	χ^2 (1)=3.829, p <.05
oo-haranige / oo-baranige	0.39	0.34	χ^2 (1)=685, p =.408, *n.s.*

In Table 3, a series of chi-square tests of independence are carried out for each item to compare voiced frequency between 1984 and 2005. Table 3 shows that the frequency of *rendaku* significantly increased in twenty-one years in the case of second elements with a voiced obstruent in the second mora (C_2) and that the frequency of *rendaku* significantly decreased in the case of second elements with the third-/fourth-positioned voiced obstruent (C_3, C_4) as illustrated in (5).

(5) Positional blocking effects in 1984 and 2005

1984		2005
C_2	>	C_2
C_3	<	C_3
C_4	<	C_4

3.3 Results

Decision tree analysis CHAID (Chi-Squared Automatic Interaction Detection) was used setting a dependent variable of a voiced or voiceless decision predicting by the three independent variables of (1) two types of first element, (2) voiced mora position of the second element, and (3) years of research of 1984 and 2005. The decision tree analysis, as shown in Figure 1, revealed the following significant trends: (1) *rendaku* with a voiced obstruent in the second mora of the second element (15.2%) occurred less frequently than in the third and the fourth mora (34.0%) [χ^2(1)=102.435, p<.001]; (2) in the case of second elements with a voiced obstruent in the second mora, the frequency of *rendaku* significantly increased in twenty-one years from 1984 to 2005 (11.9% in

1984, 17.7% in 2005) [$\chi^2(1)=5.855$, $p<.05$]; and (3) the frequency of *rendaku* significantly decreased in the case of second elements with the third-/forth-positioned voiced obstruent over twenty-one years from 1984 to 2005 (40.6% in 1984 and 29.3% in 2005) [$\chi2(1)=22.121$, $p<.001$].

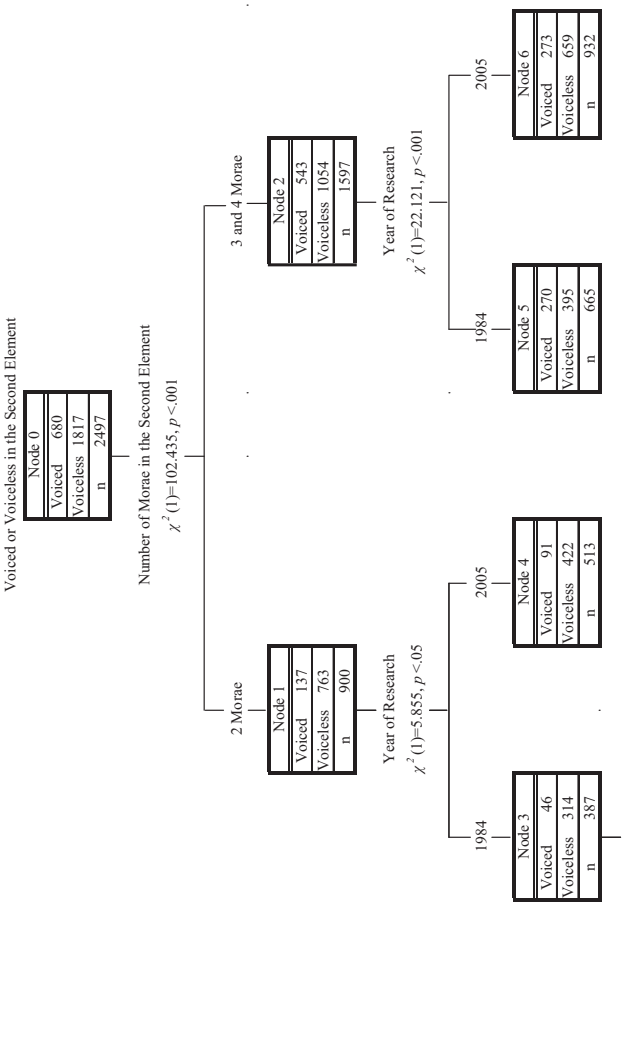

Figure 1. Decision tree analysis of Experiment 1

4. Experiment 2

Experiment 2 examined how the etymological type of lexical stratification of the first element influences *rendaku* in cases deviating from Lyman's Law. /Nawa-basigo/ 'rope ladder' is one of a few exceptions to Lyman's Law found in the existing vocabulary. Nonexistent pairs of X-hasigo and X-basigo, where X referred to any first element, were used.

4.1. Method

The participants are the same as in Experiment 1. The first elements were controlled by varying the etymological type of Japanese such as native Japanese, Sino-Japanese, and foreign loanwords. Again, the same participants were asked to judge whether or not the first mora of the second element is voiced in each question. These voiced-and-voiceless paired questions were randomly presented to participants in a single questionnaire.

4.2. Stimulus Items and Item-by-Item Analyses

As shown in Table 4 and Table 5, first elements were chosen according to three different etymological types of lexical stratification: native Japanese, Sino-Japanese (Chinese Borrowing), and foreign loan words. The first elements were native Japanese /naga/ 'long,' Sino-Japanese /tetusei/ 'iron-made,' and a foreign loan word /sutenresu/ 'stainless-steel-made.' These first elements were compounded to a pair of second elements, the voiceless /hasigo/ and the voiced /basigo/, respectively, to constitute a pair of nonwords.[1]

Table 4. Experiment 2 in 1984

1st element + 2nd element	1984 Voiceless	1984 Voiced	1984 Rate	Chi-square test of goodness-of-fit
(1) Native Japanese 1st element				
naga-hasigo /naga-basigo	7	190	0.96	$\chi^2(1)=169.99, p<.001$
(2) Sino-Japanese 1st element				
tetusei-hasigo / tetusei-basigo	127	71	0.36	$\chi^2(1)=15.84, p<.001$
(3) Foreign loan word 1st element				
sutenresu-hasigo /sutenresu-basigo	132	66	0.33	$\chi^2(1)=22.00, p<.001$

Table 5. Experiment 2 in 2005

1st element + 2nd element	2005 Voiceless	2005 Voiced	2005 Rate	Chi-square test of goodness-of-fit
(1) Native Japanese 1st element				
naga-hasigo /naga-basigo	82	175	0.68	χ^2 (1)=33.65, p <.001
(2) Sino-Japanese 1st element				
tetusei-hasigo / tetusei-basigo	188	70	0.27	χ^2 (1)=53.97, p <.001
(3) Foreign loan word 1st element				
sutenresu-hasigo /sutenresu-basigo	231	27	0.10	χ^2 (1)=161.30, p <.001

Table 4 and 5 shows that for native Japanese first elements, a significantly larger proportion of participants selected the voiced case, while for Sino-Japanese and foreign loanword first elements, a significantly larger proportion of participants selected the voiceless case.

Table 6. Comparison of 1984 and 2005 in Experiment 2

1st element + 2nd element	*Rendaku* rate 1984	*Rendaku* rate 2005	Chi-square test of independence
(1) Native Japanese 1st element			
naga-hasigo /naga-basigo	0.96	0.68	χ^2 (1)=56.88, p <.001
(2) Sino-Japanese 1st element			
tetusei-hasigo / tetusei-basigo	0.36	0.27	χ^2 (1)=3.99, p <.05
(3) Foreign loan word 1st element			
sutenresu-hasigo /sutenresu-basigo	0.33	0.10	χ^2 (1)=36.09, p <.001

Table 6 shows that for every etymological type, the frequency of *rendaku* decreased over twenty-one years.

4.3.Results

As shown in Figure 2, the decision tree analysis revealed the following significant trends: (1) the frequency of *rendaku* is marked by notable differences among etymological types from the highest ― native Japanese, Sino-Japanese, and foreign loanwords [χ2(2)=373.124, p<.001] ― and (2) for every etymological type, the frequency of *rendaku* has consistently decreased over the twenty-one-year period [χ2(1)=56.883, p<.001 for native Japanese, χ2(1)=3.994, p<.05 for Sino-Japanese, and χ2(1)=36.085, p<.001 for foreign loan words].

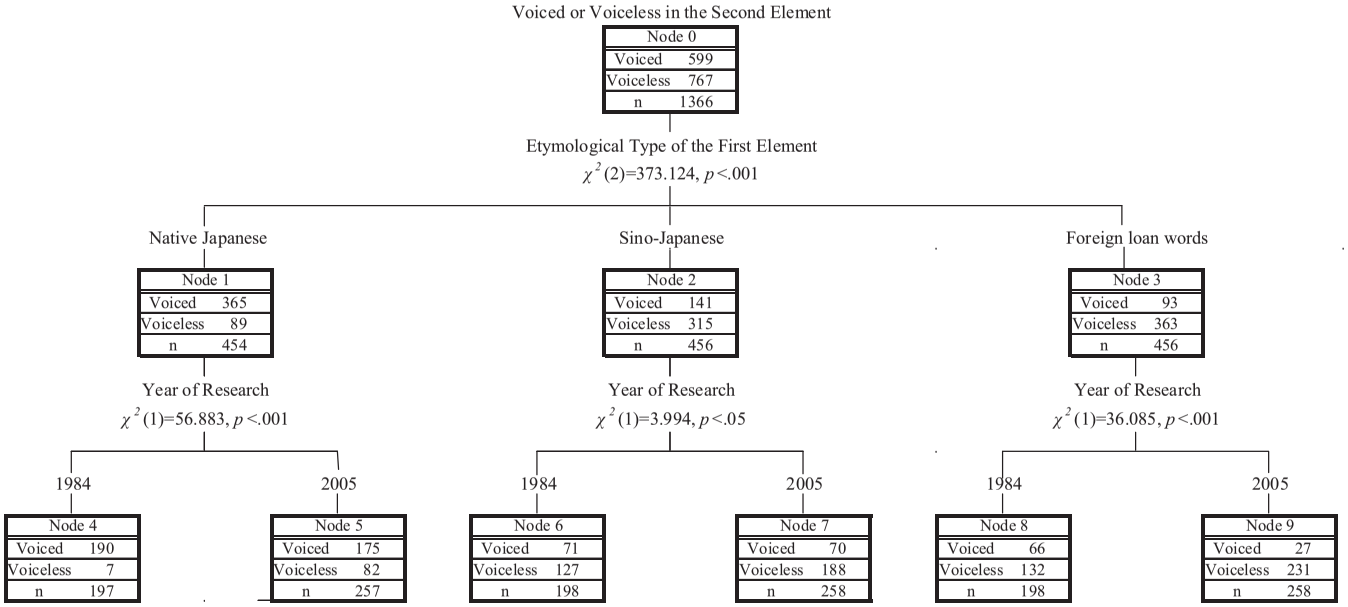

Figure 2. Decision tree analysis of Experiment 2

5. Discussion

The present study investigated Lyman's Law effect on *rendaku*. Experiment 1 demonstrated that the blocking effect of voiced obstruency was higher with voiced obstruents in the second mora position than in the third/fourth mora position. There was no significant difference in *rendaku* frequency between cases in the third mora and the fourth mora. This indicates that the blocking effect by Lyman's Law differs in strength depending on the position of the voiced obstruent contained, and what is more, there exists a gap between the second mora position adjacent to *rendaku*-targeted mora and the third/fourth mora position distant from the *rendaku*-targeted mora. The blocking effect decreases toward the end of the domain of *rendaku*. The strong effect of proximity is thus observed. Comparing the results in 2005 with those in 1984, in the case of the voiced obstruent in the second mora, Lyman's Law effect has weakened, whereas it has intensified in the case of the voiced obstruent contained in the third and fourth mora. These are opposing tendencies. This indicates that the difference in Lyman's Law effect between the second mora position and the third/fourth mora position has decreased over 21 years. Therefore, Lyman's Law differs in blocking effect depending on the position of the voiced obstruent already contained, although these differences tend to decrease. This implies that Lyman's Law is a general tendency rather than a categorical prohibition.

Experiment 2 revealed that the frequency of *rendaku* is marked by notable differences among the etymological type of the first elements.[2] The frequency of *rendaku* among native Japanese, Sino-Japanese, and foreign loanwords was observed in descending order. Comparing the results in 2005 with those in 1984, for every etymological type, the frequency of *rendaku* has consistently decreased in twenty-one years. In other words, the exceptionality of the *hasigo* exceptions to Lyman's Law tends to decrease. This reveals a tendency that in close conformance with the tenets of Lyman's Law.

Based on the two experiments and their close examinations with statistical analysis using decision tree analyses above, it may be concluded that (1) Lyman's Law, which is one case of OCP, is a general tendency rather than a categorical prohibition; (2) etymological types of the first element affect *rendaku*; and (3) the 'X-basigo' exception has closely conformed to the tenets of Lyman's Law in twenty-one years.

Notes

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1. More test items are examined in (Ihara & Murata 2006).
2. See (Tamaoka, Ihara, Murata & Lim To appear) for more extensive study.

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