Testing the OCP-labial effect on Japanese rendaku and revisiting the place of articulation of the glide /w/

Abstract

Japanese rendaku is a morphophonological phenomenon in which a morpheme-initial voiceless obstruent becomes voiced when it is the non-initial member of a compound. There are a number of factors that inhibit rendaku. A well-known factor is a voiced obstruent: rendaku does not apply if the second member of a compound already contains a voiced obstruent (i.e. Lyman's Law, or OCP (-son, voice)). There is another OCP-related factor that blocks rendaku: although /h/ usually becomes labial [b] when rendaku applies (e.g. *hako* 'box' + *hune* 'ship' → *hako**b**une* 'ark'), the rendaku application of /h/ is blocked if the following consonant is labial [m] (e.g. *suna* 'sand' + *hama* 'beach' → *suna**h**ama* 'sand beach'/**suna**b**ama*). One hypothesis regarding this rendaku blocking is that, if /h/ became labial [b], it would yield a sequence of homorganic consonants [**b**…m], which would violate a putative OCP-labial effect. However, it is unclear whether this is the true reason for the rendaku blocking, as there are only a few words in which /h/ is followed by other labial consonants, such as [ɸ]. The first aim of the current study is to examine whether the rendaku restriction applies productively to nonce words that contain labial consonants. The second aim is to examine whether the OCP-labial effect applies to words that contain the glide /w/ as well as other labial consonants, as some scholars describe it as a labial while others describe it as a velar. The results show that 1) the OCP-labial effect can be generalised in rendaku; 2) it works locally rather than non-locally; 3) its applicability is gradient according to the following consonant in the onset position; 4) the glide /w/ did not participate in the effect, suggesting the possibility that its place of articulation is phonologically non-labial.

1. Introduction

1.1 Testing the OCP-labial effect on Japanese rendaku

Japanese rendaku is a morphophonological phenomenon by which a morpheme-initial voiceless obstruent /t, k, s, h/ becomes voiced [d, g, z, b], respectively, when it is the non-initial member of a compound (e.g. McCawley 1968; Ito & Mester 1986, 2003; Vance 1980, 1987, 2015, 2016; see also Vance & Irwin 2016 for a collection of recent papers on rendaku). Illustrative examples are given in (1).

(1) Examples of Japanese rendaku

aka	‘red’	+	tama	‘ball’	→	akadama ‘red ball’
[aka]			[tama]			[aka**d**ama]
oo	‘big’	+	tako	‘octopus’	→	oodako ‘big octopus’
[oː]			[tako]			[oː**d**ako]
umi	‘sea’	+	kame	‘turtle’	→	umigame ‘sea turtle’
[ɯmi]			[kame]			[ɯmi**g**ame]
hi	‘sun’	+	kasa	‘umbrella’	→	higasa ‘parasol’
[çi]			[kasa]			[çi**g**asa]
oo	‘big’	+	same	‘shark’	→	oozame ‘big shark’
[oː]			[same]			[oː**z**ame]
oo	‘big’	+	sake	‘alcohol’	→	oozake ‘heavy drinking’
[oː]			[sake]			[oː**z**ake]
hako	‘box’	+	hune	‘ship’	→	hakobune ‘ark’
[hako]			[ɸɯne]			[hako**b**ɯne]
hude	‘pencil’	+	hako	‘box’	→	hudebako ‘pencil case’
[ɸɯde]			[hako]			[ɸɯde**b**ako]

It is well known that rendaku is blocked by Lyman’s Law if the second member of a compound already contains a voiced obstruent, as illustrated in (2). The initial consonant /t, k, s, h/ of the second member does not undergo rendaku because the second member of the compound already contains a voiced obstruent, such as [b, d, g].

(2) Rendaku blocking by Lyman’s Law

hitori	‘alone’	+	tabi	‘travel’	→	hitoritabi ‘travelling alone’
[çitori]			[tabi]			[çitoritabi]
						*hitoridabi [çitori**d**a**b**i]
ie	‘house’	+	kagi	‘key’	→	iekagi ‘house key’
[ie]			[kagi]			[iekagi]
						*ie**g**agi [ie**g**a**g**i]
kuro	‘black’	+	sabi	‘rust’	→	kurosabi ‘black rust’
[kɯro]			[sabi]			[kɯrosabi]
						*kurozabi [kɯro**z**a**b**i]
tori	‘bird’	+	hada	‘skin’	→	torihada ‘gooseflesh’
[tori]			[hada]			[torihada]
						*toribada [tori**b**a**d**a]

In addition to Lyman’s Law, there are other factors that block rendaku (see Irwin 2012 for examples of these factors). As already seen in (1), /h/ usually becomes labial [b] when rendaku applies, but the rendaku application of /h/ is inhibited if the following consonant is labial [m], as in (3)[1] (Kawahara et al. 2006; Kawahara 2015). (Note that labial [m] per se is not the potential segment that blocks rendaku, as can be seen in (1).)

(3) Rendaku blocking in [b…m]

suna [sɯna]	‘sand’	+	hama [hama]	‘beach’	→	sunahama ‘sand beach’ [sɯnahama] *sunabama [sɯna**ba**m**a**]
mai [mai]	‘dancing’	+	hime [çime]	‘princess’	→	maihime ‘dancing girl’ [maiçime] *maibime [mai**bim**e]
kutu [kɯʦɯ]	‘shoe’	+	himo [çimo]	‘lace’	→	kutuhimo ‘shoelace’ [kɯʦɯçimo] *kutubimo [kɯʦɯ**bim**o]
ma [ma]	‘genuine’	+	hamo [hamo]	‘pike conger’	→	mahamo ‘genuine pike conger’ [mahamo] *mabamo [ma**bam**o]

One hypothesis regarding this rendaku blocking is that, if /h/ became labial [b], it would yield a sequence of homorganic consonants [**b**…m], which would violate a putative OCP-labial effect. The OCP-labial effect has been observed in a variety of languages (see, e.g. Bye 2011; Goldsmith 1978; Leben 1973; McCarthy 1986; Odden 1986, 1988; Rose 2001; Suzuki 1998; Yip 1988 for OCP effects; see, e.g. Alderete & Frisch 2007; Bye 2011; Odden 1994; Selkirk 1993; Zuraw & Lu 2009 for OCP-labial effects), and some experimental studies have already demonstrated that the OCP-labial effect can apply to word formation in Japanese (Anonymous XXXX; Moon 2018). If the rendaku blocking in (3) results from the OCP-labial constraint, then it should also occur when /h/ is followed by other labial consonants, such as [ɸ, w]. However, as will be seen in Section 2, there are few real words in which /h/ is followed by [ɸ, w]; there is no knowing whether such words undergo rendaku.

The first aim of the current paper is to experimentally examine whether the rendaku blocking results from the OCP-labial effect, using nonce words that contain labial consonants [m, ɸ, w]. The results show that 1) the OCP-labial effect can be generalised in rendaku; 2) it manifests itself only when the target labial consonant is adjacent to the initial consonant /h/ in the onset position (e.g. the OCP-labial effect works in [**b**…**m**], rather than [**b**…C…**m**], where C represents a non-labial consonant); and 3) the applicability of rendaku is gradient: the rendaku blocking is more likely to apply to [**b**…**m**] than to [**b**…**ɸ**]. This final finding is observed in various

[1] Words such as *hama* ‘beach’, *hime* ‘princess’, and *himo* ‘string’ are said to be immune to rendaku (e.g. Martin 1987; Rosen 2003; Vance 1987).

languages: the more similar two consonants are, the more strongly they are disfavoured (e.g. Berent & Shimron 2003; Berent et al. 2004; Buckley 1997; Frisch et al. 2004; Greenberg 1950; Pierrehumbert 1993).

1.2 Revisiting the place of articulation of the Japanese glide /w/

The current paper addresses another issue concerning the phonology of Japanese: the place of articulation of the glide /w/. According to Maddieson (1984), 76% of the world's languages have the glide /w/. When produced, it has two points of constriction in the oral cavity and thus is often described as a labio-velar (International Phonetic Association). Cross-linguistically, some languages exhibit patterns in which the glide /w/ is a labial, while other languages exhibit those in which it is a velar or dorsal. An example showing that the glide /w/ should be specified as a labial in phonology is Karuk, or Karok, a Hokan language spoken in northwestern California (see Bright 1957 for this language). This language possesses a process called sonorant nasalisation, in which the non-nasal sonorants /w/[2] and /r/ alternate with nasals when followed by another consonant at a morpheme boundary (e.g. /asi**w**/ + /-ʧak/ → [ʔásí**m**-ʧak] 'to close one's eyes'; /si**r**/ + /-kara/ → [síː**n**-kara] 'to swallow'; cf. [ʔásíw] 'to sleep'; [sir] 'to disappear') (Levi 2008: 1965). Sonorant nasalisation can be construed as a process in which the feature [−nasal] turns into [+nasal] while the place feature remains still, if /w/ and /m/ are phonologically labials and if /r/ and /n/ are phonologically coronals.

Meanwhile, there are languages showing that /w/ should be a phonological dorsal. An illustrative example is Luganda, a Bantu language of East Africa. This language has a process that uses gemination to emphasise the nature of the thing discussed – for example, that something large is 'huge' or 'long'. The first consonant of the stem in the following examples is geminated when it is an obstruent, but when it is a sonorant /l, j, w/, it is replaced with the voiced plosive /d, ɟ, ɡ/ having the same place of articulation (e.g. /-langa/ → [ddaanga] 'lily'; /-jinga/ → [ɟɟi-inga] 'stone'; /-wanga/ → [gg^{w}aanga] 'nation') (based on the data in Kawahara 2007; see also Clements 1986; Cole 1967). In this language, if both /l/ and /d/ are phonologically coronals, both /j/ and /ɟ/ are phonologically palatals, and both /w/ and /ɡ/ are phonologically dorsals, then the process can be accounted for by converting the feature [+sonorant] into [−sonorant], with the place feature value still unchanged.

[2] /w/ is phonetically realised as a voiced bilabial fricative [β].

These examples of the two languages suggest that the place feature of the glide /w/ varies across languages. A question that arises here, then, is which of the places of articulation the Japanese glide /w/ should be: labial or velar. Phonetically, some Japanese speakers make their lips slightly rounded when they produce the glide [w] (Vance 1987). However, in introductory text-books or overview articles on Japanese phonetics and phonology, the glide is described as a labial (Kubozono 2015; Shibatani 1990), as a velar (Pintér 2015; Tsujimura 2014; Yamaguchi 2007), or as a labiovelar (Labrune 2012), which means that there is no consensus on the place of articulation of the glide; that is, no phonological evidence has been reported that determines it.[3]

The second aim of the current paper is to discuss what feature of the place of articulation is specified for the glide /w/, making use of the results of the experiment that tests the OCP-labial effect on rendaku. If the nonce words in which /h/ is followed by /w/ hesitate to undergo rendaku, it is inferred that the Japanese glide /w/ is undoubtedly specified as the feature [labial]. Meanwhile, if they do undergo rendaku, it is possible that the glide /w/ is a phonologically non-labial, as it does not block rendaku due to the OCP-labial effect. The current experiment shows that the glide /w/ did not participate in the OCP-labial effect in a particular condition, which suggests that it is a phonologically non-labial.[4]

There are a couple of assumptions that should be made. In the current paper, it is assumed that OCP-labial constraints are violated when singleton labial consonants are placed in each onset position within a word or across word boundaries. In other words, geminated labial consonants per se do not invite a violation of the OCP-labial constraints. Also, it is assumed that OCP-labial effects show up in derived environments. Kawahara et al. (2006) looked at whether the OCP-labial effect works in non-derived environments. Based on the large Japanese dictionary *Kōjien* (Shinmura 1998), they investigated whether there are co-occurrence restrictions on the

[3] Phonetically, the glide [w] may involve both lips and the dorsum of the tongue, but the current paper adopts the stance that the feature specification can be determined by phonological evidence available in each language (cf. Ohala & Lorentz 1977 for a different view).
[4] An earlier version of the current paper was open to the public as a manuscript in 2017 at Lingbuzz. Since then, a number of studies have addressed this issue (see Anonymous XXXX; Anonymous XXXX; Anonymous XXXX; Kawahara 2019 for discussion based on sound-symbolic evidence).

place of articulation in native words. The results showed that words with homorganic consonants are less likely to appear within a root than we may expect and that labial sequences (N=86) are less likely to occur than labial-coronal (or coronal-labial) sequences (N=1,335) or labial-dorsal (or dorsal-labial) sequences (N=450).[5] Kawahara et al.'s (2006) study suggests that the OCP-labial effect seems to be active in native words, in the sense that words with labial sequences are less likely to occur. However, as the authors mention, the restrictions are not absolute: in fact, there are native words with labial sequences (e.g. *mame* [mame] 'bean'; *mimi* [mimi] 'ear'; *momo* [momo] 'peach'; *humi* [ɸɯmi] 'letter, trample'). It is therefore safe to assume that, though there are fewer native words with repeated identical place of articulation than we may expect, we must admit that labial sequences, at least, are tolerated in non-derived environments.

2. A survey of rendaku

This section provides the results of a survey that investigates whether real words in which /h/ is followed by a labial consonant /m, ɸ, w/ undergo rendaku. The current analysis used the rendaku database (Irwin et al. 2017) to examine whether rendaku applies in real native words with /h…C_2(…C)/ (i.e. local condition) and /h…C…C_3/ (i.e. non-local condition), where C_2 and C_3 is any of [m, ɸ, w]. Of the five labial consonants [p, b, m, ɸ, w] that are used in Japanese, [p] and [b] were excluded from analysis, since singleton [p] rarely appears in Japanese native words (e.g. Ito & Mester 1995, 1999, 2008; Nasu 2015) and voiced [b] blocks rendaku by Lyman's Law. For comparison, whether initial-/h/ words that do not contain labial consonants undergo rendaku was also examined.

Table 1 shows the rate of rendaku application of words with /h…C_2/, where C_2 is a non-labial consonant.[6] The results indicate that the average rate is beyond 70% in each sequence: it is 82.54%.

[5] For detailed analyses, see http://user.keio.ac.jp/~kawahara/yamato.htm.
[6] The rate of rendaku of words with [h…h] is excluded from Table 1, since it is extremely low, due to the fact that there are only two lexical items (e.g. *haha* 'mother'; *hoho* 'cheek'). Only one out of seven compounds that undergo rendaku was found.

	Examples	No. of lexical items	No. of compounds	No. of rendaku	Rate (%)
h…(φV)	hae ‘fly’	17	387	308	79.59
h…kV…	hako ‘box’	15	298	267	98.6
h…tV…	hato ‘pigeon’	17	303	242	79.87
h…sV…	hasira ‘pillar’	13	373	328	87.94
h…nV…	hane ‘feather’	16	429	322	75.06
h…jV…	hayasi ‘wood’	14	87	71	81.61
h…rV…	hari ‘needle’	20	699	503	71.96
h…ɴ…	han ‘volume’	3	35	30	85.71
ALL		115	2611	2071	82.54

Table 1: Survey of real native words with /h…C_2/, where C_2 is a non-labial consonant

Table 2 indicates that the average rate of rendaku application is 74.4% when /C_3/ is a labial. On the other hand, Table 3 shows that the rendaku applicability drops sharply to 15.4% when /C_2/ is a labial.[7] Hence, the rendaku blocking occurs only in the local condition.

	Examples	No. of lexical items	No. of compounds	No. of rendaku	Rate (%)
h…C…m	hakama ‘hakama’	14	258	195	75.58
h…C…ɸ	-	0	0	0	0
h…C…w	haniwa ‘clay figure’	1	4	0	0
ALL		15	262	195	74.4

Table 2: Survey of real native words with /h…C…C_3/ (C_3 = [m, ɸ, w])

[7] The words *humi* ‘letter’ and *humi* ‘trample’ are excluded from this survey because they exceptionally undergo rendaku (Vance & Asai 2016), which is why the current experiment excludes words that begin with /hu/ from the set of stimuli (see footnote 10 in Section 3.1).

	Examples	No. of lexical items	No. of com-pounds	No. of rendaku	Rate (%)
h…m(...C)	hama ‘beach’	19	189	30	15.87
h…ɸ(…C)	huhuki ‘butterbur’	1	1	0	0
h…w(…C)	hiwa ‘cardueline finch’	1	5	0	0
ALL		21	195	30	15.4

Table 3: Survey of real native words with /h…C_2(…C)/ (C_2 = [m, ɸ, w])

As Table 3 indicates, rendaku seems to be blocked when /h/ is followed by a labial consonant, but there are few examples with [h…ɸ(…C)] and [h…w(…C)], and thus it is too early to conclude that the rendaku blocking results from the OCP-labial effect. Therefore, the current paper conducts an experiment with nonce words that examines whether rendaku blocking occurs when /h/ is followed by any of the labial consonants used in Japanese.

3. Experiment

3.1 Stimuli

To test whether the rendaku blocking in question results from the OCP-labial effect, the current experiment provides native speakers of Japanese with nonce compounds (N_2 consists of /h/-initial nonce words that contain a labial consonant, and N_1 is a real word, *nise* ‘fake’) and asks them whether it is natural for these compounds to undergo rendaku. As shown in Tables 4 and 5, the current experiment prepared two conditions to test the local effect of the OCP-labial constraint. Each target segment is located on the second-initial mora (C_2) (Table 4) and on the third-initial mora (C_3) (Table 5). There are five groups of tri-moraic nonce words in each condition.[8] The group (a) /b-t/ (or /b-C-r/) is a control group that does not contain any labial consonants. The other groups (b, c, d, e) contain a labial consonant, which may violate the OCP-

[8] Following a number of previous wug-tests on rendaku (e.g. Kawahara 2012; Kawahara & Sano 2014a, 2014b, 2016), the current experiment used only trimoraic words with a light (CV-moraic) syllable.

labial constraint if rendaku applies.[9] The group (b) also violates Lyman's Law if rendaku applies, since it already contains a voiced obstruent. Each group has three nonce words whose first vowel (V_1) is any of [a, i, o][10], and the current experiment thus uses 30 trimoraic nonce words (2 conditions*5 groups*3vowels each). The low vowel [a] is used for V_2 and V_3 in (a, b, c, e), but the high back vowel [ɯ] (= /u/) is used in (d), as the bilabial fricative [ɸ] is always followed by /u/ in native words.

		N_2			Compounds	
a.	b-t	hatara	[hatara]	→	nisebatara	[nise**b**atara]
		hitara	[hitara]	→	nisebitara	[nise**b**itara]
		hotara	[hotara]	→	nisebotara	[nise**b**otara]
b.	b-b	habara	[habara]	→	nisebabara	[nise**ba****b**ara]
		hibara	[hibara]	→	nisebibara	[nise**bib**ara]
		hobara	[hobara]	→	nisebobara	[nise**bob**ara]
c.	b-m	hamara	[hamara]	→	nisebatara	[nise**bam**ara]
		himara	[himara]	→	nisebimara	[nise**bim**ara]
		homara	[homara]	→	nisebomara	[nise**bom**ara]
d.	b-ɸ	hahura	[haɸɯra]	→	nisebahura	[nise**baɸ**ɯra]
		hihura	[hiɸɯra]	→	nisebihura	[nise**biɸ**ɯra]
		hohura	[hoɸɯra]	→	nisebohura	[nise**boɸ**ɯra]
e.	b-w	hawara	[hawara]	→	nisebawara	[nise**baw**ara]
		hiwara	[hiwara]	→	nisebiwara	[nise**biw**ara]
		howara	[howara]	→	nisebowara	[nise**bow**ara]

Table 4: A set of stimuli to test the local OCP-labial effect

[9] In the current experiment, singleton [p] was excluded from the set of stimuli, since it rarely appears in Japanese native words (e.g. Ito & Mester 1995, 1999, 2008; Nasu 2015). Long vowels were also excluded, as they do not appear in native monomorphemic words.

[10] As already explained in footnote 7, words that begin with /hu/ are excluded from the set of stimuli since they do undergo rendaku.

		N2			Compounds	
a.	b-C-r	hasara	[hasara]	→	nisebasara	[nise**b**asara]
		hisara	[hisara]	→	nisebisara	[nise**b**isara]
		hosara	[hosara]	→	nisebosara	[nise**b**osara]
b.	b-C-b	hasaba	[hasaba]	→	nisebasaba	[nise**b**asa**b**a]
		hisaba	[hisaba]	→	nisebisaba	[nise**b**isa**b**a]
		hosaba	[hosaba]	→	nisebosaba	[nise**b**osa**b**a]
c.	b-C-m	hasama	[hasama]	→	nisebasama	[nise**b**asa**m**a]
		hisama	[hisama]	→	nisebisama	[nise**b**isa**m**a]
		hosama	[hosama]	→	nisebosama	[nise**b**osa**m**a]
d.	b-C-ɸ	hasahu	[hasaɸɯ]	→	nisebasahu	[nise**b**asa**ɸ**ɯ]
		hisahu	[hisaɸɯ]	→	nisebisahu	[nise**b**isa**ɸ**ɯ]
		hosahu	[hosaɸɯ]	→	nisebosahu	[nise**b**osa**ɸ**ɯ]
e.	b-C-w	hasawa	[hasawa]	→	nisebasawa	[nise**b**asa**w**a]
		hisawa	[hisawa]	→	nisebisawa	[nise**b**isa**w**a]
		hosawa	[hosawa]	→	nisebosawa	[nise**b**osa**w**a]

Table 5: A set of stimuli to test the non-local OCP-labial effect

3.2 Participants and procedure

The current experiment was conducted online using SurveyMonkey. The participants were 76 native speakers of Japanese, all of whom were undergraduate students at a Japanese university. None of them were studying linguistics. In the instruction session, they were informed about the concept of rendaku and given a couple of actual examples. For the test, they were told that the target nonce words were used in Old Japanese, so that they would assume that the words are underlying forms. They were then asked to choose which of the forms seemed more natural than the other if each target word was combined with the word *nise*, meaning fake. Each question comprised original words and those that undergo rendaku for each nonce word (e.g. *nise**h**amara*; *nise**b**amara*). The nonce words and compounds were written in *hiragana*, a Japanese orthography typically used to represent native words. The order of 30 questions was randomised and different for each participant.

3.3 Results

3.3.1 Analytical methods

Following the previous experimental studies on rendaku (e.g. Kawahara & Sano 2014a, 2014b, 2016), the current analysis implemented a generalised mixed-effects logistic regression using the *glmer()* function of the *language R* and *lme4* packages (Baayen 2008: Baayen et al. 2008) of R (R Development Core Team 2013), as it should consider that each participant shows different responses to each item. Participants and items were coded as random effects (Baayen et al. 2008).

3.3.2 The local condition

For analysis, the applicability of rendaku between each group per condition is compared. The ratio of rendaku application for each condition is shown in Figures 1 and 2, where error bars represent 95% confidence intervals. As shown in Figure 1, in the local condition, the ratio of the rendaku application is as follows: /b-t/ = 0.711; /b-b/ = 0.189; /b-m/ = 0.39; /b-ɸ/ (represented as /b-f/) = 0.592; /b-w/ = 0.697. The results showed that there were significant differences between /b-t/ and /b-b/ (0.711 vs. 0.189; $z = -11.034$, $p < .001$), between /b-t/ and /b-m/ (0.711 vs. 0.39; $z = -7.206$, $p < .001$), and between /b-t/ and /b-ɸ/ (0.711 vs. 0.592; $z = -2.854$, $p < .01$), but not between /b-t/ and /b-w/ (0.711 vs. 0.697; $z = -0.332$, *n.s*). (There was a significant difference between /b-ɸ/ and /b-w/ (0.592 vs. 0.697; $z = 2.607$, $p < .01$).) A closer look at differences within the responses to the labial consonants shows that /b-b/ is significantly lower in the proportion of rendaku application than is /b-m/ (0.189 vs. 0.39; $z = 5.008$, $p < .001$), and /b-m/ is significantly lower than is /b-ɸ/ (0.39 vs. 0.592; $z = -4.709$, $p < .001$).

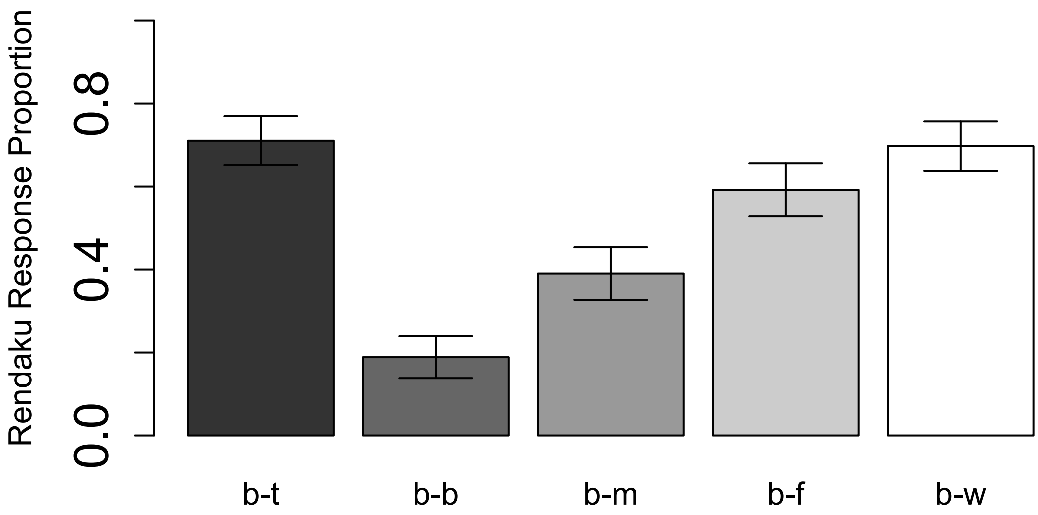

Figure 1: Rendaku applicability in the local condition

3.3.3 The non-local condition

The ratio of the rendaku application in the non-local condition (Figure 2) is as follows: /b-C-r/ = 0.715; /b-C-b/ = 0.39; /b-C-m/ = 0.671; /b-C-ɸ/ (represented as b-C-f) = 0.719; /b-C-w/ = 0.588. There was a significant difference between /b-C-r/ and /b-C-b/ (0.715 vs. 0.39; $z =$

−4.722, $p < .001$). As for the other groups, there were no significant differences between /b-C-r/ and /b-C-m/ (0.715 vs. 0.671; $z = −0.737$, *n.s*) or between /b-C-r/ and /b-C-ɸ/ (0.715 vs. 0.719; $z = −0.006$, *n.s*), though there was a slightly significant difference between /b-C-r/ and /b-C-w/ (0.715 vs. 0.588; $z = −2.001$, $p < .05$).

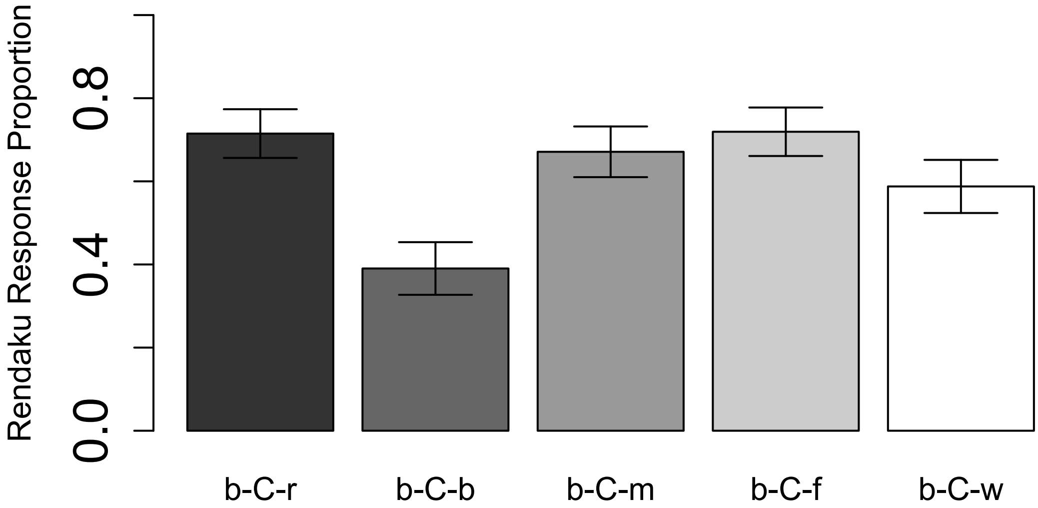

Figure 2: Rendaku applicability in the non-local condition

3.4 Discussion

The aim of the experiment is to examine whether the OCP-labial effect applies to nonce words that contain labial consonants. In the local condition, the applicability of rendaku was significantly reduced in /b-b/, /b-m/, and /b-ɸ/, while it was not in /b-w/. This can be accounted for if the place of articulation of the glide /w/ is not a labial. As with this possibility, it is unproblematic to conclude that the OCP-labial effect can be generalised in rendaku. As already mentioned in Section 1, some researchers describe the glide /w/ as a labial (Kubozono 2015; Shibatani 1990) while others describe it as a velar (Pintér 2015; Tsujimura 2014; Yamaguchi 2007) or as a labiovelar (Labrune 2012). The results of the current experiment suggest that it is phonologically non-labial. Historically, it used to be [ɸ] between tauto-morphemic vowels (e.g. [koɸaki] → [kowai] 'scary') (Hamano 2000). One may argue that this historical change could be convincing if the place of articulation of the glide /w/ is a labial and so is /ɸ/, but this assumption is not necessary when we explore what the grammar of modern Japanese speakers is like. It is probable that the glide /w/ is phonologically non-labial in modern Japanese.

The results of the experiment show differences in the applicability of rendaku among labial consonants in the second-initial onset position. The applicability of rendaku in /b-b/ showed the lowest, which suggests that Lyman's Law in tandem with the OCP-labial effect must have applied. The significant difference between /b-m/ and /b-ɸ/ suggests that the more similar two consonants are, the more strongly they are disfavoured, which has been reported in the literature (e.g. Anonymous XXXX; Berent & Shimron 2003; Berent et al. 2004; Buckley 1997; Frisch et al. 2004; Greenberg 1950; Pierrehumbert 1993). The current paper assumes that /b/ and /m/ are more similar to each other than are /b/ and /ɸ/ because both /b/ and /m/ have the feature [−continuant] while /ɸ/ has [+continuant]. Padgett (1991, 1992) argues that such OCP subsidiary features (e.g. continuancy), as well as place features, are the key to accounting for consonant co-occurrence restrictions in Russian. For example, the root *sad-* 'sit' is well-formed because the value of [continuant] differs between [s] and [d], but the root *s'oz-* is ill-formed because the two consonants share [+continuant] (see also Coetzee and Pater (2008), who make a similar assumption in their analysis of Muna and Arabic). Another reasoning by which /b/ and /m/ are more similar to each other than are /b/ and /ɸ/ is that the former pair are voiced. Yet, this possibility should be ruled out as a similarity, as rendaku applies when the second member of a compound already contains a (voiced) sonorant such as /m/, which means that a voicing feature of the sonorant /m/ is inactive in phonology.

Contrary to the local condition, the applicability of rendaku was not made lower in the non-local condition. This result is convincing when the results of the survey of real words presented in Section 2 are taken into consideration. The significant difference between /b-C-r/ and /b-C-b/ comes not from the OCP-labial effect but from the effect of Lyman's Law. The result that Lyman's Law exhibits a long-distance effect is consistent with the results of some previous experiments (Ihara et al. 2009; Kawahara 2012; Kawahara & Sano 2014b; Vance 1980).

The result that rendaku applicability is reduced in /b-C-w/ is still unaccounted for. Is it possible that this result was caused by real words that Japanese speakers possess in the lexicon? It appears not: the survey presented in Section 2 showed that there is no example in which both [h…C…ɸ] and [h…C…w] undergo rendaku, which means that the Japanese lexicon cannot offer any reason for the discrepancy in rendaku applicability between [h…C…ɸ] and [h…C…w]. At the moment, there seems to be no other factor that could block rendaku in the /b-C-w/ condition. Thus, the interim conclusion drawn by the current paper is that, since the *p* value is near 0.5 ($p = 0.045$) in the [b-C-w] condition, the result that the applicability of rendaku was slightly reduced could have been accidental. This should be examined in future research.

4. Concluding remarks

To summarise, the current paper examined whether the rendaku blocking in sequences of [b…m], such as *suna-hama* 'beach' and *mai-hime* 'a dancing girl', is attributed to the OCP-labial effect. The results showed that only in the local condition did the OCP-labial effect apply to nonce words that contain other labial consonants. In other words, the rendaku blocking in question results from the OCP-labial effect. In addition, the extent in which the OCP-labial effect applies depends on the following consonant in the onset position; the applicability of rendaku is lower in the order of sequences of [b…b], [b…m], and [b…ɸ]. This suggests that the more similar the two consonants are, the more likely the OCP-labial effect is to apply. Furthermore, rendaku does apply in sequences of [b…w], which casts doubt on the assumption that the place of articulation of the Japanese glide /w/ is a labial. The current paper proposes that it is not a labial in its phonological representation. Perhaps it may be specified with the feature [dorsal] phonologically, but, as there is no direct evidence of it, the current paper can say nothing regarding this possibility at the moment. It is necessary to gather more data to settle the issue in future research.

References

Alderete, John and Stefan Frisch. 2007. Dissimilation in grammar and the lexicon. *The Cambridge Handbook of Phonology*, ed. by Paul de Lacy, 379–398. Cambridge: Cambridge University Press.

Baayen, R. H. 2008. *Analyzing linguistic data: A practical introduction to statistics using R*. Cambridge: Cambridge University Press.

Baayen, R. H., D. J. Davidson and D.M. Bates. 2008. Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language* 59. 390–412.

Berent, Iris and Joseph Shimron. 2003. The representation of Hebrew words: Evidence from the obligatory contour principle. *Cognition* 64. 39–72.

Berent, Iris, Vered Vaknin and Joseph Shimron. 2004. Does a theory of language need a grammar? Evidence from Hebrew root structure. *Brain and Language* 90. 170–182.

Bright, William. 1957. *The Karok language*. Berkeley & Los Angeles: University of California Press.

Buckley, Eugene. 1997. Tigrinya root consonants and the OCP. *Penn Working Papers in Linguistics* 4. 19–51.

Bye, Patrik. 2011. Dissimilation. *Companion to phonology*, ed. by Marc van Oostendorp, Colin J. Ewen, Elizabeth V. Hume, and Keren Rice, 1408–1433. Oxford: Wiley-Blackwell.

Clements, George N. 1986. Compensatory lengthening and consonant gemination in LuGanda. *Studies in compensatory lengthening*, ed. by Leo Wetzels and Engin Sezer, 37–77. Dordrecht: Foris.

Coetzee, Andries W. and Joe Pater. 2008. Weighted constraints and gradient restrictions on place co-occurrence in Muna and Arabic. *Natural Language & Linguistic Theory* 26. 289–337.

Cole, Desmond. 1967. *Some features of Ganda linguistic structure*. Johannesburg: Witwatersrand University Press.

Frisch, Stefan, Janet Pierrehumbert and Michael Broe. 2004. Similarity avoidance and the OCP. *Natural Language & Linguistic Theory* 22. 179–228.

Goldsmith, John. 1976. Autosegmental phonology. Cambridge, MA: MIT dissertation.

Greenberg, Joseph H. 1950. The patterning of root morphemes in Semitic. *Word* 5. 162–181.

Hamano, Shoko. 2000. Voicing of obstruents in Old Japanese: Evidence from the sound-symbolic stratum. *Journal of East Asian Linguistics* 9. 207–225.

Ihara, Mutsuko, Katsuo Tamaoka and Tadao Murata. 2009. Lyman's Law effect in Japanese sequential voicing: questionnaire-based nonword experiments. Collection of the Papers Selected from the 18th International Congress of Linguists, 1007–1018.

Ito, Junko and Armin Mester. 1986. The phonology of voicing in Japanese: theoretical consequences for morphological accessibility. *Linguistic Inquiry* 17. 49–73.

Ito, Junko and Armin Mester. 1995. Japanese phonology. *Handbook of phonological theory*, ed. by John Goldsmith 817–838. Cambridge, MA: Blackwell.

Ito, Junko and Armin Mester. 1999. The structure of the phonological lexicon. *The Handbook of Japanese Linguistics*, ed. by Natsuko Tsujimura, 62–100. Oxford: Blackwell.

Ito, Junko and Armin Mester. 2003. *Japanese morphophonemics: Markedness and word structure*. Cambridge, MA: MIT Press.

Ito, Junko and Armin Mester. 2008. Lexical classes in phonology. *Handbook of Japanese linguistics*, ed. by Shigeru Miyagawa and Mamoru Saito, 84–106. Oxford: Oxford University Press.

Irwin, Mark. 2012. Rendaku dampening and prefixes. *NINJAL Research Papers* 4. 27–36.

Irwin, Mark, Mizuki Miyashita and Kerri Russell. 2017. The Rendaku Database v3.1.

Kawahara, Shigeto. 2007. Sonorancy and geminacy. *University of Massachusetts Occasional Papers in Linguistics 32: Papers in Optimality III*. 145–186. Amherst: GLSA.

Kawahara, Shigeto. 2012. Lyman's Law is active in loan and nonce words: Evidence from naturalness judgment studies. *Lingua* 122. 1193–1206.

Kawahara, Shigeto. 2015. Can we use rendaku for phonological argumentation? *Linguistic Vanguard*. Online publication.

Kawahara, Shigeto. 2019. What's in a PreCure name? *ICU Working Papers in Linguistics 7: Festschrift for Professor Tomoyuki Yoshida on his 60th birthday,* 15–22

Kawahara, Shigeto, Hajime Ono and Kiyoshi Sudo. 2006. Consonant co-occurrence restrictions in Yamato Japanese. *Japanese/Korean Linguistics* 14, 27–38. Stanford: CSLI Publications.

Kawahara, Shigeto and Shin-ichiro Sano. 2014a. Identity avoidance and rendaku. *Proceedings of the 2013 Annual Meeting on Phonology*, ed. by John Kingston, Claire Moore-Cantwell, Joe Pater, and Robert Staubs. Online Publication. Linguistic Society of America, Washington, DC.

Kawahara, Shigeto and Shin-ichiro Sano. 2014b. Identity avoidance and Lyman's Law. *Lingua* 150. 71–77.

Kawahara, Shigeto and Shin-ichiro Sano. 2016. Rendaku and identity avoidance: Consonantal identity and moraic identity. *Sequential voicing in Japanese compounds: Papers from the*

NINJAL Rendaku Project, ed. by Timothy J. Vance and Mark Irwin, 47–55. Amsterdam: John Benjamins.

Kubozono, Haruo. 2015. Introduction to Japanese phonetics and phonology. *The handbook of Japanese language and linguistics: Phonetics and phonology*, ed. by Haruo Kubozono, 1–40. Berlin: Mouton de Gruyter.

Labrune, Lawrence. 2012. *The phonology of Japanese*. Oxford: Oxford University Press.

Leben, William R. 1973. Suprasegmental phonology. Cambridge, MA: MIT dissertation.

Levi, Susannah V. 2008. Phonemic vs. derived glides. *Lingua* 118: 1956–1978.

Maddieson, Ian. 1984. *Patterns of sounds*. Cambridge: Cambridge University Press.

Martin, Samuel E. 1987. *The Japanese language through time*. New Haven & London: Yale University Press.

McCarthy, John J. 1986. OCP effects: Gemination and antigemination. *Linguistic Inquiry* 17. 207–263.

McCawley, James D. 1968. *The phonological component of a grammar of Japanese*. The Hague: Mouton.

Mester, Armin and Junko Ito. 1989. Feature predictability and underspecification: Palatal prosody in Japanese mimetics. *Language* 65. 258–293.

Moon, Changyun. 2018. The Influence of OCP-place on word truncation: A study of modern Japanese abbreviation of compound loanword nouns with long vowels *Japanese/Korean Linguistics* 25. Stanford: CSLI Publications.

Nasu, Akio. 2015. The phonological lexicon and mimetic phonology. *The handbook of Japanese language and linguistics: Phonetics and phonology*, ed. by Haruo Kubozono, 253–288. Berlin: Mouton de Gruyter.

Odden, David. 1986. On the role of the obligatory contour principle in phonological theory. *Language* 62. 353–383.

Odden, David. 1988. Anti antigemination and the OCP. *Linguistic Inquiry* 19. 451–475.

Odden, David. 1994. Adjacency parameters in phonology. *Language* 70. 289–330.

Ohala, John and James Lorentz. 1977. The story of [w]: an exercise in the phonetic explanation for sound patterns. *Proceedings of the Berkeley Linguistic Society* 3. 577–599.

Padgett, Jaye. 1991. Stricture in feature geometry. Amherst: University of Massachusetts dissertation.

Padgett, Jaye. 1992. OCP subsidiary features. *Proceedings of the North East Linguistic Society* 22. 335–346. University of Massachusetts, Amherst. GLSA.

Pierrehumbert, Janet B. 1993. Dissimilarity in the Arabic verbal root. *Proceedings of the North East Linguistic Society* 23, 367–381. University of Massachusetts, Amherst. GLSA.

Pintér, Gábor. 2015. The emergence of new consonant contrasts. *The handbook of Japanese language and linguistics: Phonetics and phonology*, ed. by Haruo Kubozono, 121–166. Berlin: Mouton de Gruyter.

R Core Team. 2013. *R: A Language and Environment for Statistical Computing*.

Rose, Sharon. 2001. Rethinking geminates, long-distance geminates, and the OCP. *Linguistic Inquiry* 31. 85–122.

Rosen, Eric Robert. 2003. Systematic irregularity in Japanese rendaku: How the grammar mediates patterned lexical exceptions. *Canadian Journal of Linguistics* 48. 1–37.

Selkirk, Elizabeth. 1993. Labial relations. Ms. University of Massachusetts, Amherst.

Shibatani, Masayoshi. 1990. *The language of Japan*. Cambridge: Cambridge University Press.

Shinmura, Izuru. (ed.). 1998. *Kōjien*. Tokyo: Iwanami Publishers.

Suzuki, Keiichiro. 1998. A typological investigation of dissimilation. Arizona: University of Arizona dissertation.

Tsujimura, Natsuko. 2014. *An introduction to Japanese linguistics*. 3rd edition. Oxford: Blackwell.

Vance, Timothy J. 1980. The psychological status of a constraint on Japanese consonant alternation. *Linguistics* 18. 245–267.
Vance, Timothy J. 1987. *An introduction to Japanese phonology*. New York: SUNY Press.
Vance, Timothy J. 2014. If *rendaku* isn't a rule, what in the world is it? *Usage-based approaches to Japanese grammar: Towards the understanding of human language*, ed. by Kaori Kabata and Tsuyoshi Ono, 137–152. Amsterdam: John Benjamins.
Vance, Timothy J. 2015. Rendaku. *The handbook of Japanese language and linguistics: Phonetics and phonology*, ed. by Haruo Kubozono, 397–441. Berlin: Mouton de Gruyter.
Vance, Timothy J. 2016. Introduction. *Sequential voicing in Japanese compounds: Papers from the NINJAL Rendaku Project*, ed. by Timothy J. Vance and Mark Irwin, 1–12. Amsterdam: John Benjamins.
Vance, Timothy J. and Atsushi Asai. 2016. Rendaku and individual segments. *Sequential voicing in Japanese compounds: Papers from the NINJAL Rendaku Project*, ed. by Timothy J. Vance and Mark Irwin, 119–137. Amsterdam: John Benjamins.
Vance, Timothy J. and Mark Irwin. (ed.). 2016. *Sequential voicing in Japanese compounds: Papers from the NINJAL Rendaku Project*. Amsterdam: John Benjamins.
Yamaguchi, Toshiko. 2007. *Japanese linguistics: An introduction*. London: Continuum.
Yip, Moira. 1988. The Obligatory Contour Principle and phonological rules: A loss of identity. *Linguistic Inquiry* 19. 65–100.
Zuraw, Kie and Yu-An Lu. 2009. Diverse repairs for multiple labial consonants. *Natural Language & Linguistic Theory* 17. 197–224.