P-1

The structure of Japanese reduplicated compounds: insights from apophony

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ABSTRACT: Two types of total reduplication are productive in Japanese: plural/intensive reduplication and mimetic reduplication. Based on each reduplication type's morphosyntactic and semantic properties, previous studies have argued that their structures differ. Both reduplications yield right-headed compounds; however, in plural reduplication, the head would be the base, whereas in mimetic reduplication, it would be the reduplicant. To date, there has been no strong phonological evidence to support this claim. In this study, I use new phonological data of apophonic compounds to show that the aforementioned model correctly predicts apophony in not only existing reduplicated compounds but also novel reduplicated compounds in a forced-choice experiment on native Japanese speakers.

1. Introduction

Reduplication and its typology have long been a central research field in phonology (Wilbur 1973; Marantz 1982; McCarthy & Prince 1986; Raimy 2000; McCarthy et al. 2012 *inter alia*). Reduplication is a type of affixation in which the segmental information of the affix is partially or totally copied from the stem. The exponent of the reduplicative morpheme is called the reduplicant, while the portion of the word that supplies the copied information is the base (Urbanczyk 2007: 473). The reduplicant is often considered to have no phonological features, but it can have a phonological shape (McCarthy & Prince 1986), especially in the case of partial reduplication. Although base-reduplicant correspondence has been extensively studied in recent decades, this paper does not focus on the phonological constraints on reduplication but instead on how phonological investigation could cast light on the morphological structure of reduplication in Japanese.

In Japanese, only total reduplication is productive, but it is used in two different contexts. The first is plural or intensive reduplication (1a), as in many languages. The second is called mimetic reduplication and is used to form adjectives and adverbs (1b). Henceforth, plural/intensive reduplication is abbreviated as PR, plural/intensive reduplicated compounds as PRC, mimetic reduplication as MR, and mimetic reduplicated compounds as MRC.

(1)	a. PRC:	sima-zima	"islands"	<	sima	"island"
	b. MRC:	sima-sima	"striped"	<	sima	"stripe"

Based on the morphophonological and semantic differences between the two types of reduplicated compounds, it was proposed by Nishimura (2013) that the order of the base and reduplicant is actually different for PRCs and MRCs. However, it is difficult, especially for total reduplication, to identify which element is the base and which is the reduplicant. In the following sections, I provide new phonological evidence that it is possible to identify the base of reduplicated compounds in Japanese by examining a certain type of allomorphy seen in compound words: apophony, or vowel alternation.

The next section introduces in more detail the two types of reduplicated compounds found in Japanese and the morphological structures proposed by Nishimura (2013). Section 3 presents apophony in Japanese compounds and its behavior in reduplicated compounds to support Nishimura's claim. Section 4 shows how the patterns observed in Section 3 have been confirmed experimentally. Finally, a summary and conclusion are offered in Section 5.

2. Reduplicated compounds in Japanese

Both PR and MR are total reduplication. However, they exhibit different morphosemantic characteristics. First, they do not have the same restrictions concerning lexical strata. PR (2a) is limited to native words, whereas most of the compounds created via MR involve words from the mimetic lexical strata (2b), and some from the native (2c) and foreign strata (2d) are also found.

(2)	a. PRC:	mura-mura	"villages"	<	mura	"village"	Native stratum
	b. MRC:	pika-pika	"shiny"	<	*pika	"shiny"	Mimetic stratum
	c. MRC:	siwa-siwa	"wrinkled"	<	siwa	"wrinkle"	Native stratum
	d. MRC:	rabu-rabu	"lovey-dovey"	<	rabu	"love"	Foreign stratum

MRCs do not always share the same part of speech as their base but are instead adjectives or adverbs. For example, (2c) is an adjective, although its base, *siwa*, is a noun. The meaning of MRCs also strays slightly from their base words: (2c) is not a type of wrinkle but the state of having wrinkles; (2d) is not a type of love but the state of being in love.

In comparison, PRCs usually share the same part of speech as their base, and their meaning is closer than that of MRCs.

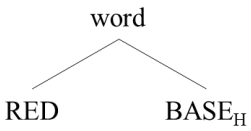
(3)	a. PRC:	kuni-guni	“countries”	<	kuni	“country”	Noun
	b. PRC:	samu-zamu	“wintry, bleak”	<	samu-i	“cold”	Adjective
	c. PRC:	kasane-gasane	“repeatedly”	<	kasane-ru	“to repeat”	Verb

The phonology of the two reduplication types is also different. Rendaku, or sequential voicing, is a morphophonological process in which the initial obstruent of the second element and head of a compound becomes voiced. MRCs never undergo rendaku, whereas PRCs almost always undergo rendaku when possible. Their accents differ as well. PRCs follow the default accent rule for compound words, i.e., the last mora of the left-hand element when the right-hand element is two mora or shorter (4a) and the first mora of the right-hand element when it is three mora or longer (4b-c). Conversely, the accent for MRCs is more complicated: they tend to be unaccented when four-mora long (bimoraic base, 4d), be accented on the first mora of the second element when six-mora long (trimoraic base, 4e), and preserve the accent of the base when eight-mora long (quadrimoraic base, 4f) (Nishimura 2013). The accent nucleus is noted below with an apostrophe and unaccented words with a final °.

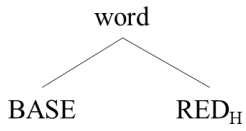
(4)	a. PRC:	hito’-bito	“people”	<	hito°	“person”
	b. PRC:	tokoro-do’koro	“here and there”	<	tokoro’	“place”
	c. PRC:	tobikoe-to’bikoe	“while jumping over”	<	tobikoe’-ru	“to jump over”
	d. MRC:	koke-koke°	“mossy”	<	koke’	“moss”
	e. MRC:	kasure-ka’sure	“cracked”	<	kasure’-ru	“to crack”
	f. MRC:	toraburu-tora’buru	“troublesome”	<	tora’buru	“trouble”

Based on the previous morphosemantic characteristics of each reduplication type, Nishimura (2013) proposed the following structure for reduplicated compounds in Japanese.

(5) a. Plural reduplication

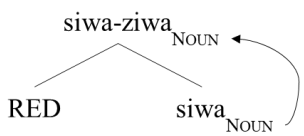


b. Mimetic reduplication

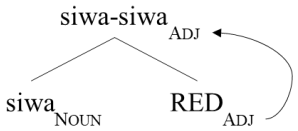


For PRCs, the base is the head and the right-hand element. MRCs, in contrast, have reduplicants as head- and right-hand elements. Although the reduplicant is phonologically null, it possesses its own part of speech, which can explain why MRCs have an adjectival and/or adverbial value regardless of the part of speech of the base.

(6) a. PRC siwa-ziwa “wrinkles”

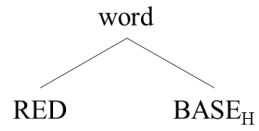


b. MRC siwa-siwa “wrinkly”

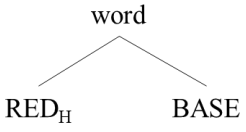


Nishimura admitted that there is no evidence in the phonological structure to determine which element is the reduplicant and which is the base and thus depended on morphosemantic evidence (Nishimura 2013: 135). His proposal relies on the assumption that reduplicated compounds are right headed; however, Huang (2020) pointed out that left-headed compounds might be more frequent than originally thought. We can then imagine an alternative structure, as shown in (7), in which the order of the reduplicant and base is the same for both reduplications, but for PRC, the head is the right element, and for MRC, it is the left-hand element.

(7) a. Plural reduplication



b. Mimetic reduplication



With only morphosemantic information, rendaku and accent patterns, it is difficult to exclude one of the two proposals. In the following sections, I examine apophony in reduplicated compounds to provide solid phonological evidence supporting Nishimura’s proposal in (5).

3. Apophony in reduplicated compounds

3.1 Apophonic compounds in Japanese

A limited set of words may undergo apophony of their last vowel only when they are the first- or left-hand element of a compound (Arisaka 1931, Martin 1952, Labrune & Irwin 2020, *inter alia*). The resulting vowel is lexically fixed, and three main patterns are found: the e/a pattern, the i/o pattern and the i/u pattern.

(8)	a. ame	"rain"	+	kasa	"umbrella"	=	ama-gasa	"umbrella"
	b. tuki	"moon"	+	yo	"night"	=	tuku-yo	"moonlit night"
	c. ki	"tree"	+	kage	"shadow"	=	ko-kage	"shade of the trees"

The covert form that only appears as the first element of a compound is called *hifukukei* in traditional Japanese linguistics, while the overt form is called *roshutsukei* (Arisaka 1931). It is mainly accepted that the overt form has derived from the covert form through vowel coalescence and thus that the covert form is older than the overt form (Yoshitake 1930, Murayama 1962, Whitman 1985, Takayama et al. 2016). Apophony is not productive in modern Japanese in the sense that no new lexeme may become apophonic. However, experimental studies have found that native speakers do use the covert form in novel compounds (Salingre 2020; Irwin & Labrune 2020).

Apophony is not systematic, and compounds that could show apophony do not always take the covert form. The propensity for each lexeme to undergo apophony seems to vary greatly as well (Labrune & Irwin 2020). The choice of the overt form over the covert form sometimes appears to be arbitrary, as in (9a) and (9b). Free variation is also observed (9c).

(9)	a. koe	"voice"	+	iro	"color"	=	kowa-iro	∗koe-iro	"tone of voice"
	b. koe	"voice"	+	gara	"pattern"	=	koe-gara	∗kowa-gara	"tone of voice"
	c. ame	"rain"	+	sitaku	"preparation"	=	ama-zitaku/ame-zitaku		"preparation for the rain"

Last, the syntactic relationship between the elements of the compound influences apophony: it appears in neither dvandva compounds (10) nor left-branching compounds (11a).

(10)	a. ame	"rain"	+	kaze	"wind"	=	ame-kaze	∗ama-kaze	"rain and wind"
	b. kami	"god"	+	hotoke	"buddha"	=	kami-hotoke	∗kamu-hotoke	"gods and buddhas"
(11)	a. [aka	"red"	+	kane	"metal"]	+	ami "net"	= aka-gane-ami	"copper net"
	b. aka	"red"	+	[kane	"metal"	+	ami "net"]	= aka-kana-ami	"red wire"

Dvandva compounds have been argued to be either double headed or left headed (Huang 2021). The difference between (11a) and (11b) is whether *kane* is the head in *aka-gane* or dependent in *kana-ami*. The impossibility for the covert form to appear in (10) and (11a) thus seems to be caused by the head status of the apophonic element. Since right-headed compounds are by far the most common in Japanese (Kageyama 1999), we might therefore wonder whether the actual context for the covert form is not the left-hand element of a compound but instead the dependent in a compound.

According to Huang (2018), compounds with first elements as the numerical classifier *hito* "one" are left headed. As shown in (12), only the overt form may appear as the second element of such compounds.

(12)	a. hito-ame	∗hito-ama	"shower, rainfall"
	b. hito-koe	∗hito-kowa	"one voice"
	c. hito-hune	∗hito-huna	"one ship"

We can thus conclude that the covert form is indeed sensitive to its position (word-internal or word-final), in addition to not being able to be the head of a compound. Apophony thus appears to be the ideal morphophonological process to test the structure of reduplicated compounds: if Nishimura's proposal is correct, then we can expect PRCs to use the overt form since their base is final and MRCs to use the covert form since their base is nonfinal and is not the head. If the alternate proposal is correct, then both PRCs and MRCs are expected to use the overt form.

3.2 Investigation of existing reduplicated compounds

A list of potentially apophonic lexemes was created using the lists provided by Martin (1952), Labrune and Irwin (2020) and Salingre (2021). Adjectives and deadjectival nouns were excluded from the list since the distinction between PR and MR is not clear in such cases. Two Japanese dictionaries (*Kojien* and *Daijisen*) were examined to find reduplicated compounds involving the aforementioned apophonic lexemes. The following compounds were retrieved.

(13)	a. PRC:	koe-goe	"voices"	<	koe	"voice"
	b. PRC:	ki-gi	"trees"	<	ki	"tree"

c. PRC:	kami-gami	“gods”	<	kami	“god”
d. PRC:	kuti-guti	“each person”	<	kuti	“mouth”
e. PRC:	tuki-duki	“each month”	<	tuki	“moon, month”
f. ?RC:	(o)te-te	“hand (baby talk)”	<	te	“hand”
g. ?RC:	(o)me-me	“eye (baby talk)”	<	me	“eye”
h. PRC:	ue-ue	“high ranking people”	<	ue	“above”
i. MRC:	uwa-uwa	“restlessly”	<	ue	“above”

Two compounds (13f-g) are baby talk expressions prefixed with honorific *o*. Since these two compounds do not seem to fit into either plural or mimetic reduplication, they are considered a special case of a sociolect and are not discussed further.

All but one of the remaining reduplicated compounds have a plural meaning and use the overt form. The minimal pair *ue-ue* and *uwa-uwa* is noteworthy: the compound showing PR uses the overt form, while that showing MR uses the covert form. PRCs choosing the overt form were predicted by both Nishimura’s and our alternate proposal, since the base is the head and right-hand element. However, the only MRC found taking the covert form confirms Nishimura’s proposal: since the base of an MRC is the left-hand element, but its head is the right-hand element, the covert form may appear as in normal right-headed compounds. In the alternate proposal, the base would be the right-hand element, forbidding the covert form from appearing. However, the above results are not sufficient to fully support Nishimura’s proposal since only one MRC was found. The next section thus presents how the productivity of the *ue-ue* and *uwa-uwa* patterns was tested experimentally.

4. Experiment

4.1 Design

A forced choice experiment was conducted in which participants chose among several possible pronunciations of novel apophonic reduplicated compounds. Target items were selected according to the following criteria: 1. their reduplicated form does not appear in dictionaries; 2. their apophony rate in Labrune and Irwin (2020) is greater than 60%; and 3. their meaning allows for both plural and mimetic interpretation. The four target items were as follows.

Table 1. Target items

Target	Answer choices
am(e/a) “rain”	ame-ame, ama-ama
kaz(e/a) “wind”	kaze-kaze, kaza-kaza
hun(e/a) “boat”	hune-hune, hune-bune, huna-huna, huna-buna
sak(e/a) “alcohol”	sake-sake, sake-zake, saka-saka, saka-zaka

For target compounds that may undergo rendaku, such as *hune*, four answer choices were presented. The reduplicated compounds were written in sinograms and answer choices in the *hiragana* syllabary. For each target, three sentences with a plural interpretation (14a) and three sentences with a mimetic interpretation (14b) were created; hence, 4 target items × 2 reduplication type × 3 sentences = 24 responses per participant.

(14) a. PR: hagesii (kaze+kaze)=de ki=ga taoreta “Trees fell because of the strong (winds)”
b. MR: (kaze+kaze) sita santyoo=de bentoo=o tabeta “We ate a lunchbox on a (windy) mountain top”

Three filler items were used: *kiri* “mist”, the reduplicated form of which is not registered in dictionaries; *hosi* “star”, the reduplicated form of which *hosi-bosi* is a PRC; and *sima* “stripe”, the reduplicated form of which *sima-sima* is an MRC. The order of the sentences and of the answer choices was randomized for each participant. There were a total of 39 participants, aged 21 to 47 years old (m=30.7, SD=6.5). They all participated voluntarily and received no compensation.

According to Nishimura’s proposal and the findings of the dictionary survey, the following results were predicted: P1. participants will choose the covert form for MRC; and P2. participants will choose the overt form for PRC.

4.2 Results

The overall apophony rate was 32.3% for mimetic contexts and 9.8% for plural contexts. The apophony rate for *sake* “alcohol” was lower (14.5% for mimetic contexts and 0.9% for plural contexts) compared to the other items (38.2% for mimetic contexts and 12.8% for plural contexts). This outcome could be attributed to the individual tendency for each lexeme to undergo apophony. In Labrune and Irwin’s (2020) corpus study, *sake*’s apophony rate was 72.4%, which is, for example, higher than that for *kaze* “wind” (60%). However, when experimentally testing the productivity of apophony,

Irwin and Labrune (2020) found that *sake* went from having the 5th highest apophony rate in their corpus to only the 9th highest (19.6%) in the experiment. This finding could possibly be explained by many compounds with left-hand elements that are the covert form of *sake* being specialized culinary terms (e.g., *saka-musi* "seafood steamed in saké") or archaisms (e.g., *saka-hogai* "celebrating with a banquet").

Figure 1. Apophony rates for *ame* "rain"

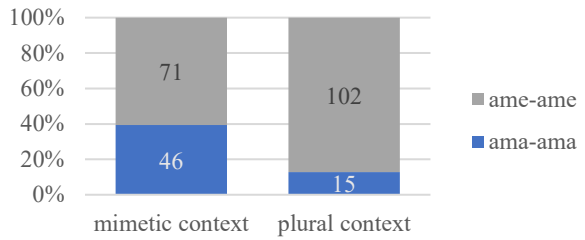


Figure 2. Apophony rates for *kaze* "wind"

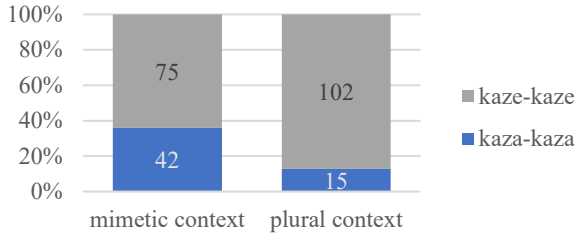


Figure 3. Apophony rates for *hune* "boat"

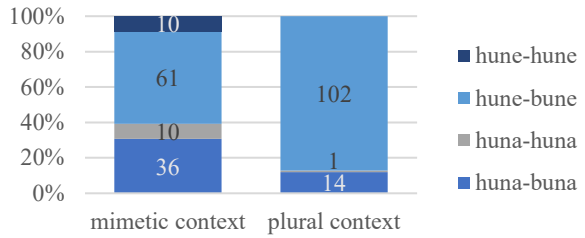
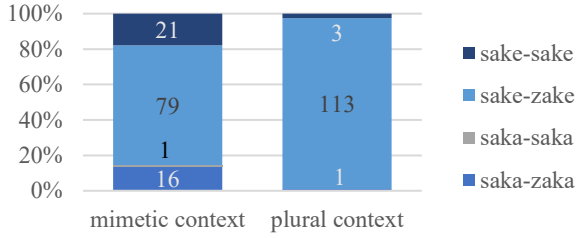


Figure 4. Apophony rates for *sake* "alcohol"



The rendaku patterns for *hune* and *sake* are quite surprising: in mimetic contexts, the +Rendaku compound was preferred, although as mentioned in Section 2, MRCs do not undergo rendaku. Moreover, the +Rendaku form was also preferred for the covert form; i.e., *huna-buna* and *saka-zaka* were chosen more often than *huna-huna* and *saka-saka*. This preference for +Rendaku forms was not limited to the target items but can also be seen in filler items: the rendaku rates were 98.3% for *hosi*, 90.6% for *kiri* and 47.9% for *sima* in PRCs, and 91.5% for *hosi*, 67.5% for *kiri* and 7.7% for *sima* in MRCs. Only *sima* "stripe" has a fairly low rendaku rate for mimetic contexts, most likely because its reduplicated form exists in the lexicon as an MRC. Even if the +Rendaku forms were preferred for both contexts for all target items and most filler items, the rendaku rate is still lower in mimetic contexts than in plural contexts. Fisher's exact test on target items found that the difference in rendaku between mimetic and plural contexts was significant (p<.001).

4.3 Statistical analysis

The 936 responses were fitted into a generalized mixed-effects logistic regression model using the *glmer* function in the *lme4* library (Bates et al. 2015), implemented in R (R Core Team 2021). Apophony was encoded as a binary variable for which the overt form was 0, and the covert form was 1. Hence, a positive slope would indicate a greater likelihood of using the covert form, while a negative slope would indicate a greater likelihood of using the overt form. The participants and target items were added to the model as random effects. The fixed effects were as follows.

(15) AGE: the participant's age (discrete numerical value)
REDTYPE: Mimetic or Plural (default value is Mimetic)
RENDAKU: +Rendaku or −Rendaku, only for items that may undergo rendaku (default value is −Rendaku)

The participant's age was added as a control variable to the model because Salingre (2020) found a significant effect of age on the application of rendaku in a forced-choice experiment with novel compounds. A first model was fitted using only the data from target items that may undergo rendaku (*hune* and *sake*). However, rendaku was not found to have a significant effect on apophony (p=.861); thus, a second model was fitted using all of the data without considering rendaku. The results of the second model are reported in Table 2.

Table 2. Generalized linear mixed-effects model

	Estimate	SE	*z* value	Pr(>|z|)
Intercept	1.49299	1.10791	1.348	0.1778
AGE	-0.08351	0.03350	-2.493	0.0127
REDTYPE=Plural	-1.84994	0.20887	-8.857	<2e-16

Apophony was significantly lower in plural contexts than in mimetic contexts (p<.001). The participants' ages also had a significant effect on apophony (p<.05): the older participants chose covert forms less often than younger participants, as shown by the negative slope of AGE in Table 2.

4.4 Discussion

The results of the experiment confirm the predictions stated in Section 4.1: the participants tended to choose the covert form for mimetic contexts and the overt form for plural contexts. Although the effect of reduplication type was significant, the covert form was far from always chosen in mimetic contexts. The overall low apophony rate for MRCs could be attributed to several factors. The first is that, as mentioned in Section 2, apophony is not systematic, and sometimes the overt form is used although the covert form could theoretically appear. The second factor is that apophony rates seem to be lower in novel compounds than in the existing lexicon: in their experiment, Irwin and Labrune (2020) reported only a 27.9% apophony rate compared to the 42% found in Labrune and Irwin's (2020) corpus study. The last factor that could have dampened apophony in MRCs is inherent to the design of the experiment: the participants were presented with stimuli written in sinograms to allow them choose the reading. However, words from the mimetic strata and MRCs are usually written either in *hiragana* or in *katakana,* while PRCs are usually written in sinograms. This difference might have caused some participants to interpret some MRCs as PRCs.

The effect of the participants' age on apophony is similar to what was reported by Ōta and Yamashita (2012), Irwin and Vance (2015), or Salingre (2020) for rendaku, in which older speakers applied rendaku less often than younger speakers. This robust effect of age on morphophonological processes must be considered when experimenting on novel and nonsense words. To the limit of the author's knowledge, there have been no studies on possible generational language changes in apophonies. Thus, further investigation is necessary to fully understand the mechanisms of apophony in modern Japanese.

Another unexpected finding is the behavior of rendaku in MR. Although rendaku rates were significantly lower in MRCs than in PRCs, compounds with rendaku were favored over those without rendaku, although MRCs have been known to not undergo rendaku. The preference for +Rendaku was found even with the covert forms, excluding the possibility of these compounds having been interpreted as PRCs. There also does not seem to be any correlation between age and rendaku rates in MRCs (Pearson's correlation coefficient r(37)=−.009, Spearman's correlation coefficient rs(37)=−.079); thus, language change can also be excluded.

It has been proposed that rendaku is a linking morpheme bearing the [voice] feature (Ito & Mester 2003). In optimality theory (OT), its application is triggered by the constraint REALIZEMORPHEME, which penalizes candidates that do not include a morpheme present in the input. Nishimura (2013) argued that the rendaku linking morpheme is not inserted in MR to explain the difference between PRCs and MRCs. However, this explanation falls short regarding the variation in rendaku application found for MRCs in our experiment. A more satisfactory explanation would come from the relative ranking of REALIZEMORPHEME and IDENTITY-BASEREDUPLICANT (IDENT-BR). Base-reduplicant correspondence has been central to the study of reduplication in OT and IDENT-BR penalizes candidates in which the reduplicant and base differ. For speakers who never apply rendaku to MRCs, IDENT-BR(voice) is ranked higher than REALIZEMORPHEME, and only the -Rendaku form is the optimal output. However, for speakers who sometimes apply rendaku to MRCs, the ranking between the two constraints is free, and both the +Rendaku form and -Rendaku form are possible outputs. For PRCs, REALIZEMORPHEME is ranked higher than IDENT-BR(voice), and only the +Rendaku form is the optimal output.

5. Conclusion

The present article reported a new morphophonological difference, apophony, between mimetic and plural reduplication in Japanese and demonstrated how the structure of these reduplicated compounds can be inferred from it. Using a dictionary survey and an experiment, Nishimura's (2013) proposal regarding the order of the base and reduplicant, as well as the identity of the head, was confirmed: both MRCs and PRCs are right headed, but the base is the left-hand element in MRCs and right-hand element in PRCs. An effect of the participants' age on apophony was also found. However, due to the lack of previous research, it is difficult to postulate whether this finding comes from language changes or from a cognitive difference in phonological and morphological rule application with aging. Research on not only apophony but also rendaku focused on different age groups, as well as longitudinal studies, appears to be necessary.

Another interesting finding of our experiment is that, although it has been commonly accepted that MRCs do not undergo rendaku, some participants did apply rendaku to a few MRCs. Since most studies involving mimetic reduplication have focused on the mimetic stratum, further experiments on the MR of the native stratum are necessary to verify whether the rendaku and accent patterns match what is found in the existing lexicon.

There is another process involving reduplication in Japanese that was not discussed in this article: the deadjectival formation of reduplicated compounds with the suffix *-sii*.

(16)	a. hana-bana-sii	“magnificent”	<	hana	“flower”
	b. yowa-yowa-sii	“frail”	<	yowa-i	“weak”
	c. hare-bare-sii	“clear, bright”	<	hare-ru	“to clear up (sky)”

After the experiment, some participants reported that they felt that this deadjectival formation would undergo apophony more robustly than normal reduplication. If this feeling can be experimentally confirmed, it could mean that the final position of the reduplicant in MRCs could have a dampening effect on apophony since the covert form cannot be word-final. However, as seen in the experimental results, this dampening effect of the reduplicant’s final position would still be weaker than that of the base’s final position in PRCs.

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