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## Can we use rendaku for phonological argumentation?

**Abstract:** This paper addresses the general issue of the quality of phonological data, using rendaku as a case study. Rendaku is a widely-discussed voicing process that accompanies compound formation in Japanese. The issue of the quality of phonological data has been discussed from time to time from various perspectives throughout the history of phonological research, and we are recently witnessing renewed interest in this topic. This paper takes up rendaku as a case study to address this issue. Rendaku has been used to argue for many theoretical devices, but it is rarely acknowledged in the theoretical literature that rendaku involves extensive lexical irregularity. The specific question addressed in this study is whether it is appropriate to use rendaku for phonological argumentation. The answer that this paper proposes is yes, but the more crucial lesson is that theoretical phonology should evaluate the quality of phonological data more explicitly. The current discussion offers a first step toward establishing general guidelines about what kind of evidence can be used to decide whether a pattern under question is phonological or not.

**Keywords:** rendaku, phonological argumentation, experimental phonology, OCP, orthography

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### 1 Introduction

Phonologists analyze phonological processes where some sounds alternate with other sounds, and construct phonological theory based on these analyses.<sup>1</sup> However, a number of researchers have pointed out that not all alternations should be used for phonological argumentation, and there are several reasons for this.

One concern comes from the observation that some alternations involve gradient changes, which is hard to reconcile with the view that a phonological process changes one category to another. For example, in English, coda [l] is velarized, and it is tempting to use this process for phonological argumentation. Sproat and Fujimura (1993) showed, however, that the degree of velarization is gradient (i.e. it is not a matter of yes-velarized or not-velarized), and that the degree of velarization correlates with the strength of phrase boundaries at which the [l] is located. Similarly, Nolan (1992) found that in English phrasal place assimilation, where word-final coronal consonants appear to assimilate to the following dorsal consonants (as in *late call*), the assimilation is not complete: [t] in *late* does not fully become [k]. Although a later study by Ellis and Hardcastle (2002) found that some speakers show categorical changes, this general finding offers us a good lesson – some apparent “phonological patterns” may not involve a change in categories (see also Hayes 1992). A perhaps more thorny problem is that a single language can show both a categorical and a gradient version of the same alternation, and one proposed solution is to treat the former as phonological and the latter as phonetic (e.g. Cohn 1993; Zsiga 1997). It follows then that not all alternations can be used for phonological argumentation.

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<sup>1</sup> This paper sets aside phonotactics. Whether phonotactic knowledge is governed by grammar or instead governed by lexical statistics is also an important issue (see e.g. Berent et al. 2007; Daland et al. 2011; Frisch et al. 2004; Hay et al. 2003; Kager and Pater 2012; Ohala 1986), but this paper remains neutral about this debate.

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Another concern comes from the observation that some patterns are not replicable with nonce words, and therefore their productivity is in doubt. Being non-productive would mean that the pattern is lexicalized and no longer a part of a productive phonological grammar. This concern was, for example, raised by Ohala (1974), who argued against the productivity of velar softening in English using a nonce word experiment (though see also Pierrehumbert 2006). To take another example from Japanese, the past tense formation involves various “phonological” processes (e.g. post-nasal voicing, velar deletion, epenthesis, etc.). Vance (1987), however, showed that these changes are not fully replicated in experimental settings. Later studies consistently failed to replicate the alleged “phonological” patterns in the past tense formation (Batchelder 1999; Griner 2005; Vance 1991). As Vance (1991, 156) states, “[the experimental result] is consistent with the claim that even morphologically regular Japanese verb forms are stored in the lexicon.” The fact that the patterns are not productive unfortunately went unacknowledged in theoretical linguistics (e.g. Davis and Tsujimura 1991; Ito and Mester 1995; Lombardi 2002; Rice 1993). There is thus a disconnect between the descriptive literature (e.g. Vance’s 1987 well-known introductory book), and the theoretical literature. To the extent that phonological theory is about a *generative* component of a grammar, phonological theory should be based on processes that are productive.

A third concern comes from the (small) number of relevant examples. Again to illustrate this problem with Japanese, the palatalization patterns found in mimetic forms have been argued to instantiate a case of conflicting directionality (Zoll 1997), in which coronal and non-coronal consonants show different directionality effects when they attract the palatalization morpheme (Hamano 1986; Mester and Ito 1989; Zoll 1997). Alderete and Kochetov (2009) showed, however, that there are not many examples supporting this claim, and there are also a number of counterexamples; their native speaker consultants did not replicate the expected patterns either. Therefore, it is important to make generalizations based on a sufficient number of examples.

These concerns have been acknowledged from time to time within the theoretical phonology community (de Lacy 2009, 2014; Hayes 1995; Kawahara 2011a,b; Ohala 1974, 1986; Nolan 1992). For example, Hayes states that “I occasionally wondered, ‘Where is the normal phonology that I was trained to study?’” (Hayes 1995: 68) – processes that seem to apply more or less automatically without exceptions now appear to be “phonetic-y” and those morpho-phonological patterns that seem irrelevant to phonetics appear to be non-productive and/or come with many exceptions. Considering these issues, it is clear that the quality of phonological data should be examined more carefully (for recent general discussion, see de Lacy (2009, 2014); Kawahara (2011a, 2011b); see also Schütze (1996) for a similar concern in syntax).

In this general theoretical context, this paper explores what kind of evidence can be used to decide whether a pattern under question is phonological or not, especially when the pattern is morpho-phonological with extensive lexical irregularity. This paper takes *rendaku* as a case study. The conclusion that this paper offers may be debatable, and I fully expect that some people may disagree with some of the arguments that I make below. Nevertheless, what is important is that we explicitly discuss this issue; only after we accumulate case studies of this sort, can we make a step toward establishing general guidelines about what kind of evidence can be used to decide whether a pattern under question is phonological or not.

## 2 A case study: *rendaku*

### 2.1 What is *rendaku*?

With the concerns discussed in Section 1 in mind, this paper examines *rendaku*, which is a voicing process that accompanies compound formation in Japanese (e.g. /oo + *tanuki*/ → /oo-*danuki*/ ‘big raccoon’).<sup>2</sup> The way phonologists often put it is, for example, “a rule of sequential voicing – *Rendaku* – voices initial obstruents in second elements of compounds” (Ito and Mester 1986: 50).

<sup>2</sup> I use abstract phonemic transcriptions in this paper, except in Section 5 where the phonetic details are relevant. This paper uses a widely adopted phonemic transcriptions.

A more lexically-oriented characterization has been proposed by Vance (2014):

Many Japanese morphemes exhibit a well-known voicing phenomenon called *rendaku*. Such a morpheme has one allomorph beginning with a voiceless obstruent and another allomorph beginning with a voiced obstruent. An example is a morpheme meaning ‘bird’: it appears with voiceless initial /t/ in /tori/...‘bird’...and it appears with voiced initial /d/ in /hati + dori/...‘hummingbird’. When a morpheme shows this kind of alternation...it is customary to say that *rendaku* occurs in a word that contains this allomorph (p. 137, with slight modifications on transcription).

This characterization treats *rendaku* as a matter of the distribution of two allomorphs, and does not posit or imply the existence of “a phonological voicing rule”.

The reason behind this careful wording is because *rendaku* involves much lexical irregularity. Vance (2015) provides a recent overview of various factors that affect the applicability of *rendaku*. One irregular aspect of *rendaku* is the fact that it is restricted to native words. However, even this etymological characterization often fails in actuality; many native items fail to undergo *rendaku* and some non-native items undergo *rendaku*. In addition, it is often not predictable whether *rendaku* applies to a particular compound or not. Some near minimal pairs are shown in (1). The pair in (1)d is particularly telling, as the two members of the pair are semantically almost identical.

- (1) Lexical irregularity of *rendaku*
- a. /kuro-**k**ami/ ‘black hair’ vs. /aka-**g**ami/ ‘red hair’
  - b. /kata-**k**ana/ ‘katakana spelling’ vs. /hira-**g**ana/ ‘hiragana spelling’
  - c. /niwa-**t**ori/ ‘chicken’ vs. /yama-**d**ori/ ‘mountain bird’
  - d. /ero-**h**on/ ‘porn magazines’ vs. /bini-**b**on/ ‘porn magazines’
  - e. /asi-**k**use/ ‘leg habit’ vs. /kuti-**g**use/ ‘mouth habit’

Furthermore, there are some items that never undergo *rendaku*, even when these items violate no constraints that systematically inhibit *rendaku* application. For examples, there are no reasons – phonological or morphological – that items like /kemuri/ ‘smoke’ and /tuyu/ ‘dew’ cannot undergo *rendaku*, but they do not undergo *rendaku* in actuality (Vance 2014: 140). For these items, there are no phonological or morphological reasons for *rendaku* not to occur, but *rendaku* does not apply.

There is nothing new about these observations – in the first comprehensive generative treatment of Japanese phonology, McCawley (1968) states that he is “unable to state the environment in which the ‘voicing rule’ applies... [t]he relevant data are completely bewildering” (footnote 18). Ohno (2000: 163) goes so far as to say that “*rendaku* is not a productive synchronic phonological rule. [The experimental result reported in Ohno (2000)] contradicts the rule-based analyses of Otsu (1980) and Itô and Mester (1986)”. Provided below is another quote from Vance (2014):

According to Okumura (1955), it is extremely difficult to specify when *rendaku* occurs, although there are certain tendencies. This candid assessment could perhaps be improved slightly by replacing the words ‘extremely difficult’ with the word ‘impossible’; certainly nothing in the half century of subsequent research on *rendaku* suggests that Okumura was overly pessimistic (pp. 139–140).

The current paper can be understood as a constructive response to such a lexicalist view of *rendaku*. Is it possible to not be so “pessimistic” as to throw *rendaku* out from phonology entirely?

## 2.2 The role of *rendaku* in phonological theory

Why should we worry about the possibility of *rendaku* not being phonological? The most important reason is because *rendaku* has been used to argue for many theoretical devices in the phonological literature. These theoretical claims would lose their empirical ground if *rendaku* were not phonological at all – phonological theorization should be made based on phonological data, rather than something else, such as lexicalized patterns.

To flesh out this point in closer detail, theoretical works on *rendaku* have identified five important properties, listed in (2), which have had significant theoretical ramifications (see Kawahara and Zamma, to appear for details).

- (2) Rendaku is...
- a voicing process.
  - blocked when the morpheme already contains a voiced obstruent (= Lyman's Law).
  - not blocked by [+voice] in sonorants.
  - blocked when the second element is a left branch constituent of a compound (= Right Branch Condition).
  - opaque with respect to velar nasalization.

These properties have been used to argue for the following theoretical positions in (3)-(7):

- (3) As a voicing process, rendaku is:
- an autosegmental spreading rule (Ito and Mester 1986).
  - a morphologized version of intervocalic voicing (Ito and Mester 1996).
  - a reflection of a universal morpheme realization requirement (Ito et al. 2003a).
- (4) Lyman's Law is evidence for:
- a deletion rule of a floating feature (Ito and Mester 1986).
  - OCP (+voice) (Ito and Mester 1986).
  - self local-conjunction of \*VOICED OBS (Ito et al. 2003a).
- (5) Sonorant voicing is ignored by Lyman's Law because:
- it is underspecified (Ito and Mester 1986).
  - sonorants do not bear [voice] (Mester and Ito 1989).
  - obstruents and sonorants bear different voicing features (Rice 1993).
- (6) Right Branch Condition arises because:
- phonology is sensitive to c-command (Otsu 1980).
  - morpheme concatenation applies cyclically (Ito and Mester 1986).
  - different morphological branching results in different prosodification (Ito et al. 2003a).
- (7) The opaque interaction between rendaku and Lyman's Law is evidence for:
- Sympathy Theory (Ito and Mester 1997).
  - the distinction between lexical and post-lexical phonology (Ito et al. 2003b).

How convincing each argument is not crucial. More important is the simple fact that rendaku and its properties have been extensively used for phonological argumentation, and that rendaku has been made famous among the field of phonological theory in general.

An additional reason to address the question of whether rendaku is phonological or not is that rendaku appears in a number of introductory phonology (Gussenhoven and Jacobs 2011: 58; Kenstowicz 1994: 493, 511–512; Roca 1994: 75–76; Spencer 1996: 60–61), but none of them mentions its lexical irregularity. One danger is that those who read these textbooks, if they do not know Japanese well, may think that rendaku is a regular exception-less pattern. Personally, I have met a few non-Japanese professional linguists who misunderstood rendaku in this way.

To reiterate, I am not claiming that we cannot use rendaku for phonological argumentation. Quite the contrary, in the face of lexical irregularity, I am proposing that we should evaluate whether we can use rendaku for phonological argumentation in a way that is more careful and explicit.

### 3 Experimental evidence that rendaku has phonological aspects

Now we move on to reasons to think that rendaku is indeed phonological, or better put, rendaku has a phonological aspect. We can eliminate two of the concerns raised in Section 1 quite easily; nobody would

argue that rendaku is a gradient, “phonetic-y” process, because rendaku occurs at the time of compound formation. Few people would argue that there are only a small number of examples of rendaku, unlike the case of mimetic palatalization, because there are in fact many examples of forms undergoing rendaku (see Ito et al. 2003a; Irwin and Miyashita 2013).

The most thorny issue is therefore its productivity. Further, some independent evidence that rendaku is phonological would be desirable. We will address these issues in the next two sections. This section first discusses experimental evidence that rendaku is phonologically productive.

### 3.1 Experimental evidence I: the behavior of nonce words

Many experiments have tested aspects of rendaku, using nonce words (Kawahara to appear). Some of the studies used a forced-choice wug test (Kawahara and Sano 2014b), whereas other studies used elicitation production (Vance 2014) or ratings of naturalness (Kawahara 2012) (see Berko 1958 *et seq.* for the use of nonce words in phonological experimentation; see Kawahara 2011a for a recent review). These experiments show that rendaku applies to nonce words, often enough to suggest that it is at least partly productive.

In Kawahara’s (2012) naturalness rating experiments, which used a 5-point scale from “very unnatural (= 1)” to “very natural (= 5)”, nonce words with rendaku were scored on average 3.42 in Experiment 1 (in which the participants were told that the stimuli were old native words) and 3.35 in Experiment II (in which the participants were told to treat the stimuli as nonce words). Rendaku applying to nonce words was therefore not rated to be unnatural – both when the stimuli were treated as old native words and when they were treated as nonce words.

In a recent forced-choice wug test reported by Kawahara and Sano (2014b), nonce words underwent rendaku about 58% of the time, when they did not violate Lyman’s Law. If rendaku did not have a productive aspect, we would not expect rendaku to apply to nonce words at all. The 95% confidence interval ranged from 55% to 61%, which does not overlap with 50%. The result thus means that rendaku applies to nonce words more often than the chance frequency.

Another point to note is the clear effect of Lyman’s Law (= (2)b). In the wug experiments, those nonce words that violate Lyman’s Law are less likely to undergo rendaku than those nonce words that do not (e.g. Kawahara and Sano 2014b; Vance 1980). Also rendaku is rated as less natural when it violates Lyman’s Law than when it is not (Kawahara 2012). As Vance (2014: 143) puts it, then: “Does it make sense to say that there is a constraint [= Lyman’s Law] on something (i.e., *rendaku*) that is not itself a rule?”. At the very least, rendaku’s behavior in nonce word experimentation (i) is systematic in that it is sensitive to Lyman’s Law, and (ii) can be argued to be phonologically conditioned, to the extent that Lyman’s Law can be independently characterized as a phonological principle such as OCP (+voice) (Ito and Mester 1986).

### 3.2 Experimental evidence II: children’s behavior

Having observed that rendaku can apply to nonce words and that rendaku is subject to Lyman’s Law in experimental settings, there is additional experimental evidence that rendaku has phonological aspects.

Fukuda and Fukuda (1994) built on the general observation that children with specific language impairment (SLI) fail to learn productive linguistic processes, whereas they can learn lexical information without difficulties (Paradis and Gopnik 1997). The experiment was a word-formation task using children with and without SLI. The children with SLI applied rendaku to infrequent or novel compounds much less frequently than children without SLI. Since the previous findings show that SLI children fail to learn productive rules, the fact that the SLI children failed to apply rendaku to unfamiliar compounds supports the idea that rendaku is a productive phonological process.

In contrast, children with SLI generally showed rendaku in frequent compounds. This result indicates that some frequent compounds with rendaku are stored in memory. The results by Fukuda and Fukuda

(1994) thus support the view that rendaku has both lexical and productive aspects. No one who is versed in the complexities of rendaku would argue that rendaku is purely phonological without any lexical influence – what is important is that rendaku *can be* productive, which is consistent with the view that rendaku is at least partly phonologically-governed. See also Kubozono (2005) for its more recent interpretation of this experiment.

### 3.3 Experimental evidence III: ERP evidence

Kobayashi et al. (2014) report an ERP-based neurolinguistic experiment that further supports the view of rendaku as rule-governed. ERP is an electrophysiological brain response to stimuli, and it is now known that different types of ERP – LAN, P600, N400 – are observed in response to different kinds of linguistic stimuli. The experiment found that Japanese speakers show LAN and P600 in response to rendaku-undergoing stimuli, using those items that do not usually show rendaku (e.g. /nomi-domo/ ‘drinking friends’ from /tomo/ ‘friends’, which is usually pronounced as /nomi-tomo/). LAN is independently known to appear as a result of over-application of regular linguistic rules (Weyerts et al. 1997), and P600 is also observed in response to similar stimuli (at least in some cases) (Morris and Holcomb 2005). In short, the overapplication of rendaku induces neurological responses that are similar to those observed in other cases of overapplication of grammatical rules. Therefore, Kobayashi et al.’s results support the rule-based nature of rendaku from the perspective of neurolinguistics.

## 4 Rendaku interacts with phonological constraints

In addition to the experimental evidence considered above, there are some additional reasons to think that rendaku has phonological aspects. The arguments are based on the fact that rendaku is subject to phonological principles that are independently motivated on cross-linguistic grounds.

### 4.1 Markedness hierarchy among voiced obstruents

Ihara et al. (2011) addressed which consonants are most likely to undergo rendaku using a wug-test, and found the following hierarchy: /h/ > /k/ = /t/ > /s/, where /h/ is most likely to undergo rendaku and /s/ is least likely to undergo rendaku. This hierarchy can be interpreted as reflecting the markedness hierarchy,  $*/z/ \gg */g/, */d/ \gg */b/$  (/h/ becomes /b/ after rendaku).<sup>3</sup> This hierarchy is compatible with what is arguably universal (Hayes and Steriade 2004), reflecting the cross-linguistic markedness patterns and phonetic challenges that voiced obstruents present. Voiced fricatives are cross-linguistically more marked than voiced stops, because voiced fricatives require high intraoral air pressure to cause frication, but at the same time the high intraoral air pressure makes it difficult to maintain airflow across the glottis (Ladefoged and Maddieson 1996; Ohala 1983). The rendaku application hierarchy among voiced stops is also compatible with the cross-linguistic markedness scale and with the aerodynamic difficulty hierarchy: the further back the oral occlusion is, the quicker the intraoral air pressure goes up, resulting in the cession of glottal airflow (Hayes and Steriade 2004; Ohala 1983; Ohala and Riordan 1979).

<sup>3</sup> This aspect of rendaku, in which /h/ turns into /b/, can be considered as an instance of an unnatural phonological rule which arose as a result of a historical change (Bach and Harms 1972 *et seq.*): the /h/ in Modern Japanese was historically /p/ (see Vance 2015 and references cited therein). See Section 5 for related discussion.

To the extent that these markedness considerations are motivated in the phonology of other languages (Hayes and Steriade 2004), it seems reasonable to conclude that rendaku is phonological, because it interacts with a cross-linguistically motivated phonological markedness hierarchy.

## 4.2 Prohibition against the adjacent homorganic consonants

The second piece of evidence comes from a prohibition against a pair of homorganic consonants in adjacent syllables, again a restriction that is known to hold in many different languages, most famously in Semitic languages (e.g. McCarthy 1979). In Japanese too, there is a stochastic tendency in the lexicon to avoid pairs of homorganic consonants, both in native words (Kawahara et al. 2006) and mimetic words (Hamano 1986).

This co-occurrence restriction interacts with rendaku. /h/ becomes labial /b/ as a result of rendaku. Given this alternation, words of the form /hVmV/ do not undergo rendaku, whereas words of the form /hVnV/ do (Kawahara et al. 2006). This contrast is illustrated in (8) and (9).

### (8) /hVmV/ words

- a. /hama/ -/suna-**hama**/ ‘sand beach’
- b. /hamo/ -/oo-**hamo**/ ‘big hamo (fish name)’
- c. /hima/ -/kake-**hima**/ ‘provide free time (= to fire)’
- d. /hime/ -/mai-**hime**/ ‘dancing princess’
- e. /himo/ -/kutu-**himo**/ ‘shoe lace’
- f. /hema/ -/oo-**hema**/ ‘big mistake’

### (9) /hVnV/ words

- a. /hana/ -/ai-**hana**/ ‘Aibana (flower name)’
- b. /hane/ -/te-**hane**/ ‘hand wing’
- c. /hina/ -/nagasi-**hina**/ ‘floating doll’
- d. /huna/ -/oo-**huna**/ ‘big gibel’
- e. /hune/ -/oo-**hune**/ ‘big ship’

This blocking of rendaku in (8) can be understood as avoidance of creating the surface [bVmV] configuration, which itself comes from avoidance of a pair of two adjacent labial consonants.<sup>4</sup> To the extent that this restriction is motivated phonologically, again the blocking of rendaku in (8) constitutes evidence that rendaku has a phonological dimension.

## 4.3 Identity avoidance

Finally, Kawahara and Sano (2014c) identified yet another phonological factor that interacts with rendaku, namely, avoidance of two adjacent identical CV moras (i.e. Identity Avoidance). Their nonce-word experiment showed that rendaku is more likely to apply when the two moras across a morpheme boundary are identical (e.g. [ika + **kaniro**]) than when they were not (e.g. [ika + **taniro**]); i.e., Identity Avoidance increases the applicability of rendaku, or in other words, rendaku applies to avoid a sequence of identical CV moras.

The experiment also showed that rendaku is less likely to apply when it would result in two adjacent identical moras across a morpheme boundary (e.g. [iga + **ganiro**]) than when it would not (e.g. [iga + **daniro**]). Identity Avoidance decreases the applicability of rendaku.

To the extent that Identity Avoidance is a phonological constraint (Yip 1998; Walter 2007), rendaku is at least partly phonological. The dual nature of Identity Avoidance is also interesting: it is a classic

<sup>4</sup> Since rendaku does not change place of articulation of coronal or dorsal consonants, we do not know whether this restriction generalizes to any pair of consonant with the same place of articulation.

observation about phonological constraints that they can both trigger and block phonological processes (i.e. “conspiracy”: Kisseberth 1970). Identity Avoidance interacts with rendaku in such a way that it shows characteristics of typical phonological constraints.

## 5 Orthographic explanations of rendaku and Lyman’s Law

The previous section surveyed arguments that rendaku has phonological aspects. Before jumping to the conclusion that rendaku is indeed phonological, this section addresses one alternative analysis of rendaku, which any phonological theory of rendaku should take seriously; namely, an orthographic explanation of rendaku and Lyman’s Law.

As noted by Vance (to appear), rendaku is not simply a matter of “voicing of initial consonants”, but instead involves more complicated pairings of sounds when viewed at the surface phonological level. The surface phonological pairs that are related by rendaku are shown in (10). For each pair, the original sound is shown on the left, and the one that appears after the application of rendaku is shown on the right.

- (10) Pairing of sounds related by rendaku
- a. [ɸ]–[b] (e.g. [ɸue]–[bue] ‘flute’)
  - b. [ç]–[b] (e.g. [çi]–[bi] ‘fire’)
  - c. [h]–[b] (e.g. [ha]–[ba] ‘tooth’)
  - d. [t]–[d] (e.g. [ta]–[da] ‘field’)
  - e. [ts]–[z] (e.g. [tsuma]–[zuma] ‘wife’)
  - f. [tɕ]–[z] (e.g. [tɕikara]–[zɕikara] ‘power’)
  - g. [k]–[g] (e.g. [ki]–[gi] ‘tree’)
  - h. [s]–[z] (e.g. [sora]–[zora] ‘sky’)
  - i. [ç]–[z] (e.g. [çima]–[zima] ‘island’)

Among those, (d, g, h, i) are straightforward minimal pairs of sounds that differ in voicing, but the others are not. Of course this complexity is not insurmountable; for example, for (a-c), it is possible to posit underlying /p/ (McCawley 1968), which is realized as /h/ in non-voicing contexts and as /b/ in voicing contexts; /h/ further undergoes allophonic changes before /i/ and /u/, realizing as [çi] and [ɸu]. The deaffrication in (e, f) is also expected as a result of independently motivated intervocalic deaffrication, because rendaku usually occurs in intervocalic contexts.

In response to Vance (to appear), it is not impossible – or not even undesirable – to construct a phonological analysis of the complicated patterns in (10) in this way. Nevertheless, it is important to note that from the view point of orthography, all the pairings in (10) can be treated as an addition of the same diacritic mark (*dakuten*) (Vance to appear). All the letters for the sounds that appear on the right in (10) are identical to those letters that represent the sounds on the left, with addition of the *dakuten* diacritic mark (e.g. は vs. ば for [ha] vs. [ba]). Rendaku therefore can simply be understood as “the addition of a *dakuten* marker”: see the supplementary material for the complete list of the Japanese symbols corresponding to (10).

Treating rendaku as a matter of orthography appears to come with additional virtues. Recall that Lyman’s Law ignores voicing in sonorants, and several theoretical devices were proposed to account for that observation (= (5)). However, there is a simple explanation in terms of orthography: Japanese orthography marks voicing on obstruents with the *dakuten* diacritic, but not on sonorants. Therefore, Lyman’s Law can also be understood as a prohibition against two *dakuten* diacritics. This orthographic formulation of Lyman’s Law would also explain why /g/, after becoming [ŋ], would still block rendaku (= (2)e), because [ŋ] is written with a *dakuten* mark.

There is yet another independent argument for an orthographic formulation of Lyman’s Law in the loanword phonology. Geminate consonants can devoice when they co-occur with a voiced obstruent (e.g. /beddo/ → /betto/ ‘bed’) (Nishimura 2006), and this devoicing can be understood as an effect of Lyman’s Law. Moreover, /p/ seems to cause devoicing of geminates as well (e.g. /piramiddo/ → /piramitto/ ‘pyramid’;

/kyuupiddo/ → /kyuupitto/ ‘cupid’). This observation raises the possibility that this devoicing occurs because /p/ also has a diacritic mark in the Japanese orthographic system (*han-dakuten*) (i.e. ぱ (= [pa]) and ば (= [ba]) form a natural class in that they trigger devoicing of geminates). It is then very straightforward to say that Lyman’s Law prohibits two diacritics within a morpheme.

Given these considerations, should we say that rendaku and Lyman’s Law are purely orthographic? Perhaps not quite. First, children start acquiring rendaku well before they start learning the Japanese orthographic system (Sugimoto 2013), which cannot be explained if rendaku is purely a matter of orthography. Second, Kawahara and Sano (2014a) found that Japanese speakers avoid creating identical consonants in adjacent syllables by way of rendaku (e.g. \*/iga+gomoke/ from /iga+/komoke/). The consonantal identity effect cannot be reduced to an orthographic matter, because, for example, /ga/ and /go/ do not share the same symbol in Japanese. Third, rendaku occurs even when the morphemes undergoing rendaku are written with a Chinese character, which does not show the *dakuten* diacritic. Fourth, the view that rendaku is purely a matter of orthography has a hard time explaining the evidence discussed in Sections 3 and 4: why would purely orthographic processes be sensitive to phonological conditions and show features of regular rules in experimentation?

Finally, Haruka Fukazawa (p.c.) informed me that when her child learned rendaku, he over-applied rendaku to almost every lexical item before he learned orthography, which indicates that rendaku may at first be acquired as a productive, exception-less phonological rule. It is thus possible that lexical irregularity is acquired in later stages of acquisition, possibly along with the acquisition of orthographic knowledge. A more systematic longitudinal study of acquisition is certainly hoped for (see Sugimoto 2013), not only to address this specific issue about the influence of orthography, but also to address the general issue of whether rendaku is grammatical or not.

To summarize, the intention of this section was not to dismiss the phonological account of rendaku in favor of an orthographic explanation. The real take-home message of this section is that phonologists should not simply ignore orthographic factors. Ultimately, it may be that both phonological and orthographic knowledge influence the behaviors of Japanese speakers concerning rendaku (and possibly other phonological patterns).

## 6 Conclusion

The question that this paper raised was: Can we use rendaku for phonological argumentation? The answer that this paper proposed is “yes”, while bearing in mind its lexical irregularity and possible influence from orthography. This answer may not come as a surprise for many practicing phonologists. However, the bigger message that this paper wanted to raise goes beyond this simple question-and-answer: it is important to examine the quality of phonological data with explicit discussion, and this paper is a concrete exercise of this practice. Ultimately, even if not all of the arguments presented in this paper hold true upon fuller study, this paper does not lose its value, as long as the importance of the discussion of the quality of phonological data is appreciated.

It is hoped that this paper opens up discussion on the quality of phonological data for different phenomena in different languages. Based upon that research enterprise, we should be able to construct more principled guidelines about what kind of evidence can be used to decide whether a phenomenon under question is phonological or not.

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