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Phonetic naturalness and unnaturalness in Japanese loanword phonology

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Abstract This paper argues that phonetic naturalness and unnaturalness can interact within a single grammatical system. In Japanese loanword phonology, only voiced geminates, but not voiced singletons, devoice to dissimilate from another voiced obstruent. The neutralizability difference follows from a ranking which Japanese speakers created on perceptual grounds: IDENT(voi)$_{Sing}$ » IDENT(voi)$_{Gem}$. On the other hand, the trigger of devoicing—OCP(voi)—has no phonetic underpinning because voicing does not have phonetic characteristics that would naturally lead to confusion-based dissimilation (Ohala, Proceedings of Chicago Linguistic Society: Papers from the parasession on language and behaviour, 1981, in: Jones (ed.) Historical linguistics: Problems and perspectives, 1993). OCP(voi) in Modern Japanese originated as a phonetically natural OCP(prenasal) in Old Japanese because the spread out heavy nasalization would lead to perceptual confusion, but it divorced from its phonetic origin when prenasalization became voicing. The interaction of the three constraints in Modern Japanese suggests that phonetic naturalness (the ranking IDENT(voi)$_{Sing}$ » IDENT(voi)$_{Gem}$) and unnaturalness (OCP(voi)) co-reside within a single module.

Keywords Phonetic (un)naturalness · Perceptibility · Dissimilation

1 Introduction

This paper addresses the issues surrounding phonetic naturalness in phonology. Many phonological patterns seem to make phonetic sense. For example, many languages disfavor voiced stops, and the dispreference seems rooted in an aerodynamic

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challenge. During a stop closure, intraoral air pressure rises, but the rise would make it difficult to maintain voicing because there needs to be a drop in transglottal air pressure in order to produce voicing (Ohala 1983).

Because many phonological patterns seem to be shaped by phonetic factors, some scholars have proposed that these phonetic factors are encoded in synchronic phonological grammars. In other words, phonetic imperatives—such as minimization of articulatory effort or maximization of perceptual distinctiveness—synchronically shape phonological behaviors (e.g., Boersma 1998; Flemming 1995; Stampe 1973; Steriade 2001).

Other proposals have attributed the naturalness of phonological patterns to phonetically natural diachronic sound changes and kept the synchronic phonology free of phonetics because synchronic phonology can include phonetically unnatural patterns (e.g., Anderson 1981; Bach and Harms 1972; Blevins 2004). The primary argument is that several phonetically natural sound changes can result in phonetically unnatural phonological patterns. For example, Icelandic had palatalization of velar stops before front vowels, a phonetically natural process, given tongue-body coarticulation (Keating and Lahiri 1993). However, Icelandic historically changed *[æ] to [ai], but the diphthong with a back vowel nucleus still triggers fronting (Anderson 1981). Thus the historical diphthongization of [æ] to [ai] yielded a phonetically unnatural pattern, i.e., palatalization triggered by a back vowel. In this view, phonetic naturalness descends only from sound changes, and synchronic phonology is phonetics-free.

I draw on both positions, each of which I believe captures genuine aspects of phonology. I argue that phonetically natural and unnatural patterns can coexist within a single module of a synchronic grammar. Formally, I propose that synchronic phonology is directly constrained by phonetic factors but nonetheless accommodates phonetically unnatural patterns. My proposal rests on a phonological analysis and experimental studies of devoicing of voiced geminates observed in Japanese loanword phonology (Kawahara 2006).

My arguments develop as follows. Section 2 presents patterns of voiced consonants in Japanese phonology and shows that voiced geminates are more devoicable than voiced singletons. In Sect. 3, I analyze the difference in devoicability within Optimality Theory (OT; Prince and Smolensky 2004). In Sect. 4, I show that neutralizability of voicing contrasts depends on the phonetically natural principle of perceptibility. In Sect. 5, I argue that the constraint that triggers devoicing is phonetically unnatural. I summarize the results in Sect. 6, and discuss broader implications of the study. In particular, although phonetically natural and unnatural patterns can coexist within a single grammar, proving that phonological grammars are flexible enough to accommodate both, synchronic phonology nevertheless seems biased toward phonetic naturalness.

2 Data: voiced consonants in Japanese phonology

This section presents the pattern of voiced consonants in Japanese phonology (Kawahara 2006). Native Japanese phonology prohibits voiced geminates; there are

no native words like **wabba*, **wadda*, or **wagga*. Potential instances of voiced geminates are resolved by nasalization of the first portion of the geminates. The suffix *-ri* induces gemination of root-final consonants, as in (1a), but when that process would geminate a voiced obstruent, the form surfaces instead with a homorganic nasal-obstruent sequence, as in (1b).

(1) Coda nasalization in Japanese

a. /tapu+μ+ri/	→	[ta**pp**uri]	*[ta**mp**uri]	'a lot of'
b. /zabu+μ+ri/	→	[za**mb**uri]	*[za**bb**uri]	'splashing'

However, voicing in geminates has become contrastive in recent loanwords. In loanwords, coda consonants—including voiced obstruents—which follow a lax vowel in the source language are often borrowed as geminates (Katayama 1998). Some near-minimal pairs of voiced and voiceless geminates in loanwords are given in (2). Henceforth, those words that contain voiced geminates but no other voiced obstruents are referred to as TVDDV words.

(2) Voicing in geminates is contrastive in loanwords

ha**bb**uru	'Hubble'	ka**pp**uru	'couple'
ki**dd**o	'kid'	ki**tt**o	'kit'
e**gg**u	'egg'	ne**kk**u	'neck'

In the TVDDV words shown in (2), voiced geminates do not devoice, suggesting that a voicing contrast is phonemic in geminates. However, Nishimura (2003) has pointed out that voiced geminates can undergo optional devoicing when they co-occur with another voiced obstruent, as illustrated in (3). These words, which contain voiced geminates and additional voiced obstruents, are referred to as DVDDV words in the subsequent discussion.

(3) Voiced geminates devoice when they appear with another voiced obstruent

ge**bb**erusu	~	ge**pp**erusu	'Göbbels'
gu**dd**o	~	gu**tt**o	'good'
do**gg**u	~	do**kk**u	'dog'

Devoicing of voiced geminates in DVDDV words is attributable to the Obligatory Contour Principle (OCP: Leben 1973) on voicing, which is a constraint against two voiced obstruents within the same stem. This constraint is also known as Lyman's Law, and it is visibly active in the prohibition of stems with two voiced obstruents in the native phonology; e.g., *fu**d**a* 'amulet', ***b**uta* 'pig', *****b**u**d**a* (Itô and Mester 1986; Lyman 1894). In loanwords, however, singletons do not devoice—unlike geminates—even when they violate OCP(voi), as illustrated in (4) (henceforth referred to as DVDV words).

(4) Words with two singletons do not undergo devoicing

ba**g**ii	'buggy'	**b**o**g**ii	'bogey'
da**g**u	'Doug'	**d**ai**b**u	'dive'
gi**g**a	'giga (10^9)'	**g**a**b**urieru	'Gabriel'

In short, DVDDV words can undergo devoicing whereas DVDV words cannot: put differently, OCP(voi) can devoice only voiced geminates but not voiced singletons. The next section presents an analysis of why singletons and geminates differ in their devoicablity in Japanese loanword phonology.

One note is in order before proceeding: this paper focuses on the synchronic behavior of a [voi] feature in the sector of the lexicon that can be identified as loanwords by native speakers rather than the process of loanword adaptation. In other words, the analysis concerns what happens *after* speakers borrow new words rather than what happens *when* they borrow these words.

3 An OT analysis

I now turn to an analysis of the patterns summarized in Sect. 2, largely following the analysis presented in Kawahara (2006). To recast the generalization in (2)–(4), a voicing contrast is less stable in geminates than in singletons in that only voiced geminates can devoice under the duress of OCP(voi). To directly implement different neutralizability of singletons and geminates within OT (Prince and Smolensky 2004), we can separate the faithfulness constraint for [voi] into two IDENT(voi) constraints: $\text{IDENT(voi)}_{\text{Sing(leton)}}$ prohibits devoicing of singletons and $\text{IDENT(voi)}_{\text{Gem(inate)}}$ prohibits devoicing of geminates. In Japanese loanwords, $\text{IDENT(voi)}_{\text{Sing}}$ outranks $\text{IDENT(voi)}_{\text{Gem}}$. Section 4 justifies the ranking of the two constraints in terms of perceptibility of [voi] in Japanese singletons and geminates.

In addition to splitting IDENT(voi) into two constraints, I argue that the cause of devoicing in DVDDV words is a constraint against a pair of two voiced obstruents within a stem, which is well motivated in the native phonology of Japanese.[1] Following Itô and Mester (1986), I refer to this restriction as OCP(voi).

OCP(voi) and the two separate faithfulness constraints $\text{IDENT(voi)}_{\text{Sing}}$ and $\text{IDENT(voi)}_{\text{Gem}}$ can account for the patterns presented in (2)–(4). First, since singletons do not devoice due to OCP(voi) in DVDV words, $\text{IDENT(voi)}_{\text{Sing}}$ dominates OCP(voi), as shown by the tableau in (5).

(5) $\text{IDENT(voi)}_{\text{Sing}}$ » OCP(voi): No devoicing in DVDV words

/bagii/		$\text{IDENT(voi)}_{\text{Sing}}$	OCP(voi)
a. →	[bagii]		*
b.	[bakii]	*!	
c.	[pagii]	*!	

In contrast, in DVDDV words, geminates can devoice. Those cases suggest that OCP(voi) can rank above $\text{IDENT(voi)}_{\text{Gem}}$, as shown in (6). To allow for the

[1] Since devoicing takes place in words like /deibiddo/ 'David' which contain three underlying voiced consonants, OCP(voi) should assign a violation mark for each pair of voiced consonants within a stem rather than for each stem that contains two voiced obstruents (Tesar 2007).

optionality of devoicing, OCP(voi) and IDENT(voi)$_{Gem}$ can be left unranked with respect to one another (Anttila and Cho 1998).

(6) OCP(voi) » IDENT(voi)$_{Gem}$: Geminates can devoice in DVDDV words

/baggu/		OCP(voi)	IDENT(voi)$_{Gem}$
a.	[baggu]	* !	
b. →	[bakku]		*

Finally, since voiced geminates surface as voiced unless OCP(voi) is relevant, IDENT(voi)$_{Gem}$ is ranked above the markedness constraint that prohibits voiced obstruent geminates, *VOIOBSGEM, as shown in (7).

(7) IDENT(voi)$_{Gem}$ » *VOIOBSGEM: Geminates do not devoice in TVDDV words

/eggu/		IDENT(voi)$_{Gem}$	*VOIOBSGEM
a. →	[eggu]		*
b.	[ekku]	*!	

To summarize, the ranking IDENT(voi)$_{Sing}$ » OCP(voi) » IDENT(voi)$_{Gem}$ » *VOIOBSGEM accounts for all of the patterns of [voi] in the loanword phonology of Japanese. The next section justifies positing *two* IDENT(voi) constraints and makes the case for their ranking.

4 Naturalness: phonetically-determined devoicability threshold

4.1 Neutralizability based on perceptibility

Based on the behavior of [voi] in singletons and geminates with respect to OCP(voi), I have argued in Sect. 3 that Japanese loanword phonology exhibits the ranking IDENT(voi)$_{Sing}$ » IDENT(voi)$_{Gem}$. It is worth emphasizing that nothing in the native phonology of Japanese motivates the ranking between IDENT(voi)$_{Sing}$ and IDENT(voi)$_{Gem}$. The native phonology resolves voiced geminates by nasalizing the initial portion of the geminates, not by devoicing (e.g., /zabu+μ+ri/ → [za**mb**uri], *[za**pp**uri], as shown in (1b)). Therefore, prior to loanword adaptation, Japanese speakers have not seen voiced geminates, let alone devoicing of voiced geminates. Given that, why would Japanese speakers devoice only voiced geminates due to OCP(voi) in loanwords?

I argue that the ranking of IDENT(voi)$_{Sing}$ » IDENT(voi)$_{Gem}$ derives from a perceptibility scale of voicing contrasts. I propose that speakers project faithfulness rankings that go beyond what can be inferred from their native phonology. For the case at hand, Japanese speakers know that a voicing contrast is less perceptible in geminates than in singletons and accordingly project the

ranking IDENT(voi)$_{Sing}$ » IDENT(voi)$_{Gem}$. More generally, speakers exert stronger grammatical pressure against larger perceptual disparities. In OT we can formalize that behavior by making the perceptibility of a phonological alternation correlate with the ranking of a faithfulness constraint that it violates (Steriade 2001); from the perceptibility scale x > y > z, we project the constraint ranking IDENT(x) » IDENT(y) » IDENT(z). To maintain this hypothesis, we must show that a voicing contrast is less perceptible in geminates than in singletons.

4.2 Experimental evidence of unequal perceptibility

Both acoustic and perceptual evidence suggests that a voicing contrast is less perceptible in geminates than in singletons, at least in Japanese.[2] Acoustically, voiced geminates in Japanese are partially devoiced. An experiment reported in Kawahara (2005, 2006) based on the recording of three native speakers shows that voiced geminates in Japanese are partially devoiced whereas voiced singletons are voiced throughout the closure. Figure 1 shows respective closure voicing of singletons and geminates.

To quantify the general degree of partial devoicing, the proportion of closure voicing duration to closure duration was calculated based on the average of all three speakers. The result shows that while closure voicing is fully maintained in singletons, on average only the first 40% of the entire closure shows voicing in geminates. Considering that closure voicing is one of the most important cues signaling [+voi] (Lisker 1978; Raphael 1981; see Sect. 5.1 below), we expect the partial devoicing to undermine the percept of [+voi] in geminates.

A perceptual experiment reported in Kawahara (2005, 2006) confirms that a voicing contrast is less perceptible in geminates than in singletons. The experiment was a forced-choice identification task with 17 native speakers of Japanese, using naturally produced tokens covered by multi-layered cocktail party noise. The participants identified the voicing quality of [p,t,k,b,d,g,pp,tt,kk,bb,dd,gg], each of which was repeated 72 times. Based on the identification results obtained, I calculated a sensitivity measure (d') for the voicing contrast in singletons and geminates. I used d' rather than a percent correct analysis because d' directly represents the perceptibility of contrasts (Macmillan and Creelman 2005).

The average d' for the voicing contrast in singletons across all of the 17 listeners is 3.79, which significantly differs from zero ($t(16) = 34.15$, $p < .001$). The average d' for a voicing contrast in geminates is .71, which also significantly differs from zero ($t(16) = 11.47$, $p < .001$). These results show that for Japanese listeners, a voicing contrast is perceptible in both singletons and geminates, even under noisy environments. However, the perceptibility of a voicing contrast is much higher for singletons than for geminates; a paired t-test comparing d' for singletons and

[2] To the extent that the low perceptibility of a voicing contrast in geminates is due to partial devoicing, the devoicing in DVDDV words is a case in which language-particular phonetics affect phonological patterns since partial devoicing is specific to Japanese, e.g., it is not observed in Arabic. However, it is unlikely that a voicing contrast can ever be more perceptible in geminates than in singletons because we then incorrectly predict the existence of a language which permits only voiced geminates, not voiced singletons (see Kawahara 2006, Sect. 6.2).

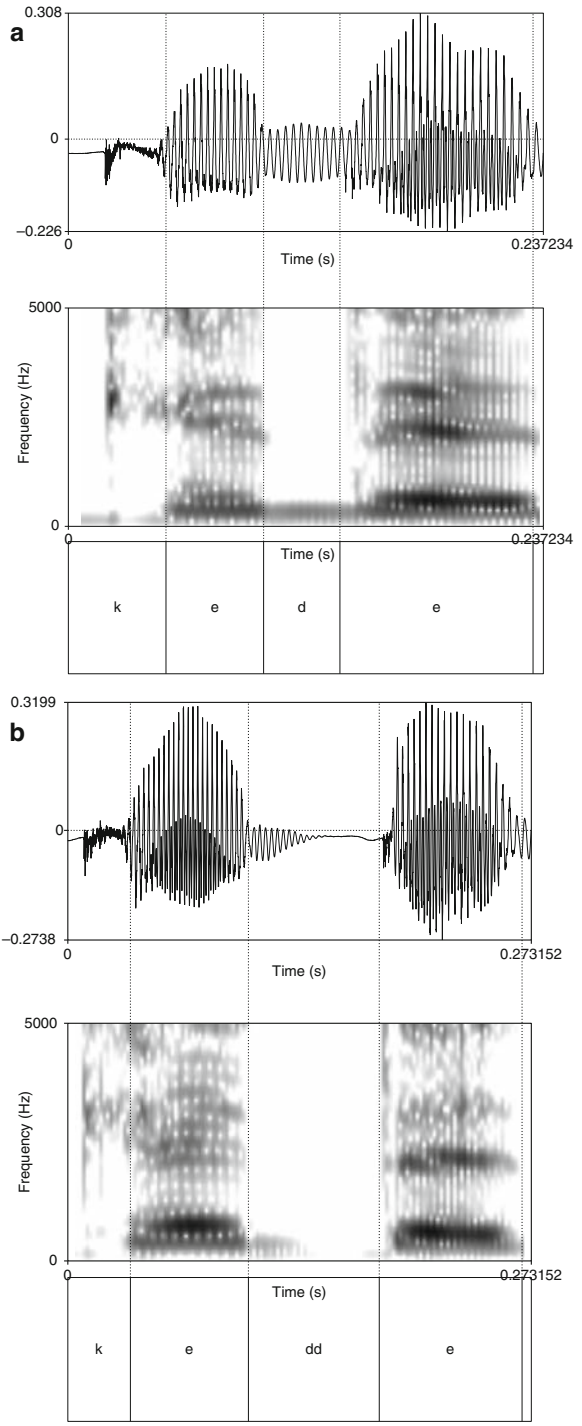

Fig. 1 Waveforms and spectrograms of a singleton [d] (**a**) and geminate [dd] (**b**) (based on Kawahara 2005, 2006)

geminates reveals a significant difference ($t(16) = 27.27$, $p < .001$). The lower perceptibility of a voicing contrast in geminates supports the hypothesis that a phonological contrast more easily neutralizes when it is less perceptible.

The results of the perceptual experiment also reveal that the perceptibility of a voicing contrast in geminates depends on the place of articulation: $d'_{\text{bb-pp}}(.82) > d'_{\text{dd-tt}}(.64) > d'_{\text{gg-kk}}(.15)$. The relation between perceptibility and the place of articulation is at least partially reflected in the likelihood of optional, phonological devoicing of voiced geminates in DVDDV words (shown in (3)). Only one DVDDV word contains /bb/ (*gebberusu*), so it is difficult to make any conclusive generalizations about /bb/. On the other hand, in Nishimura's (2003) data, the likelihood of optional devoicing for /dd/ and /gg/ is /dd/ = .15 < /gg/ = .24. In other words, the likelihood of devoicing (/dd/ = .15 < /gg/ = .24) negatively correlates with the perceptibility ($d'_{\text{dd-tt}} = .64 > d'_{\text{gg-kk}} = .15$): the more perceptible a voicing contrast is, the less likely it is to be neutralized.

These experimental results suggest that the higher devoicability of geminates is rooted in their low perceptibility. Neutralizability and perceptibility should automatically correlate in a novel loanword phonological pattern if speakers avoid neutralizing a highly perceptible contrast (Steriade 2001). In other words, the ranking $\textsc{Ident}(\text{voi})_{\text{Sing}}$ » $\textsc{Ident}(\text{voi})_{\text{Gem}}$ has the phonetically natural basis of a perceptibility scale.

5 Unnaturalness: OCP(voi)[3]

Having justified the ranking of $\textsc{Ident}(\text{voi})_{\text{Sing}}$ » $\textsc{Ident}(\text{voi})_{\text{Gem}}$ on perceptual grounds, we now turn to the discussion of the trigger of devoicing, OCP(voi).

5.1 Unnatural status of OCP(voi)

OCP(voi) is a phonetically unnatural constraint because voicing does not have phonetic characteristics that would naturally lead to dissimilation. Ohala (1981, 1993) proposes that dissimilative principles—phonologically expressed as OCP—derive from potential perceptual confusions. Dissimilation takes place between segments that have acoustic correlates that are 'stretched out' or extended due to coarticulation and can therefore be perceived in positions distant from the feature's original host. Some examples of features involving spread-out acoustic correlates are rhoticity, nasalization, and glottalization. Dissimilation can arise when listeners assume that only one segment is specified of that feature because positing one segment alone can explain the spread-out acoustic correlates. Dissimilation would also arise if speakers actively avoid such perceptually confusable configurations (Boersma 1998; Flemming 1995; Liljencrants and Lindblom 1972). Regardless of whether dissimilation is initiated by listeners' innocent hypercorrection or speakers' active avoidance of confusable configurations, perceptual confusions serve as a seed

[3] This section builds on Ohala (1981, 1993). The hypothesis that multiple tokens of voiced consonants do not cause perceptual confusion needs to be tested experimentally, but I leave this task for future research.

for dissimilation, and therefore only features that have stretched-out acoustic correlates are predicted to dissimilate.[4]

If perceptual confusion serves as a seed for a dissimilative requirement, a voicing contrast should not dissimilate because acoustic correlates for a voicing contrast are not stretched out. Ohala (1993, pp. 253–254) explicitly states that grounding dissimilation on potential perceptual confusion predicts

> that [voice] should not be subject to dissimilation. Although one might conclude that there are 'prosodic' or long time-window cues to voicing…in fact there is no evidence supporting such claims…[T]he primary cue to a segment being voiced is the generally robust cue of periodic pulsation in the lower frequencies. This cue operates in a relatively short time-window and does not manifest itself by colouration of adjacent segments; therefore it should not be susceptible to dissimilation.

Some studies have shown that acoustic correlates of a voicing contrast do spread out to some extent, affecting the F0 and F1 of surrounding vowels (Hawkins and Nguyen 2004; van Summers 1988). However, the spread-out acoustic correlates do not seem substantial enough to cause perceptual confusion and hence would not yield dissimilation. First of all, spread-out acoustic correlates of a voicing contrast may not be consistently present. In Japanese, for example, F0 and F1 differences in the steady state of the preceding and following vowels—potential instances of spread cues—are small and subject to large inter-speaker variability (Kawahara 2005).

Second and more importantly, the perceptual impact of spread-out acoustic correlates of a voicing contrast is weak at best. Some evidence shows that closure voicing constitutes the primary cue for a voicing contrast. First, Raphael (1981) found that the absence of closure voicing can cause a strong [−voi] percept in English listeners even when other cues favor a [+voi] percept and concluded that closure voicing is the dominant cue for voicing. Second, Lisker (1978) has shown that consonants with 120 ms closure duration and 40 ms closure voicing are perceived by English listeners as voiceless about 70% of the time even when other cues such as preceding vowel duration favor a [+voi] percept. Third, my perception experiment, discussed above, shows that once closure voicing is diminished in voiced geminates, so is the perceptibility of [+voi]. Finally, some previous studies demonstrate that spread-out correlates of voicing—F0 and F1—visibly affect listeners' categorization only when the dominant cue is ambiguous (Abramson and Lisker 1985; Whalen et al. 1990).

Taken together, these pieces of evidence indicate that the effect of potentially spread-out acoustic correlates of the [voi] contrast is perceptually weak and unreliable,

[4] A phonological characteristic of dissimilative requirements suggests an important caveat for the hypothesis that dissimilation arises from perceptual confusion. Some cases of dissimilation are non-local and apply in a domain as large as words (e.g., Old Japanese; see Unger 1975), but such long-distance misperception is unlikely. Therefore, given a perceptually confusable configuration, speakers may generalize the restriction due to local perceptual confusion to a larger domain. Thus, ''phonetically grounded constraints'' have original phonetic motivations—such as avoidance of perceptually confusable configurations—but also involve abstract generalizations, such as extension of their domains.

and the internal cue—closure voicing—primarily determines the voicing percept. It is thus difficult to argue that multiple tokens of voiced obstruents within a domain have any particular vulnerability to perceptual confusion. Therefore, the presence of OCP(voi) in any phonology is unexpected, given the phonetic grounding of dissimilation.[5]

5.2 A natural origin of OCP(voi) in Japanese

Where does OCP(voi) come from, if not from a phonetic source of dissimilation? The answer lies in the history of Japanese voiced obstruents: voiced obstruents formerly involved a contrast that had spread-out cues. Several pieces of evidence indicate that the voicing contrast in Modern Japanese was a prenasalization contrast in Old Japanese (Unger 1975; Vance 2005). The historical prenasalized status of modern voiced obstruents is evidenced first by the transcriptions of the 17th century missionary Rodriguez in *Arte da Lingoa de Japam* (Rodriguez 1930); some Korean and Chinese transliterations dating to the 14th century also mark voiced obstruents in Japanese with nasality. Second, some conservative dialects (such as Tosa or Tôhoku dialects) still preserve the prenasalization.

Some evidence also shows that the prenasalization in Old Japanese exhibited spread-out acoustic correlates because of coarticulatory nasalization. Rodriguez (1930, p. 637) writes that prenasalization realized itself as partial or full nasalization of the preceding vowel. In fact, prenasalization is cross-linguistically extensive almost to the degree that the whole closure can be nasalized and only the release is oral (Huffman 1993), presumably because nasalization needs extended temporal span for it to be perceived (Whalen and Beddor 1989). Given [^{n}dV^{n}d] sequences, the vowel can then be nasalized right up to the release of the first stop by coarticulation, effectively making that release nasal. Thus the spread-out heavy nasalization makes the prenasalization contrast a plausible candidate for dissimilation because the heavy nasalization can serve as a seed for perceptual confusion (Ohala 1981, 1993).[6,7]

We also have evidence that the OCP affected the phonology of Old Japanese when the contrast involved prenasalization rather than voicing (Unger 1975; Vance

[5] Frisch (2004) proposes that dissimilative restrictions on homorganic consonants found in Arabic and other languages have their functional root in difficulty in serialization. However, the evidence that multiple tokens of non-homorganic voiced obstruents cause a serialization problem is yet to be found. Given the previous findings that dominant cues for a voicing contrast are internal cues and also given the observation that voicing dissimilation can arise only through a diachronic change, it seems reasonable to maintain the hypothesis that voicing dissimilation is phonetically unnatural. Future experiments should address the question of whether two occurrences of voiced obstruents present any challenge to listeners.

[6] Languages that exhibit dissimilation in (pre)nasalization include Muna (Coetzee and Pater 2005), Gurindji (Evans 1995, p. 733), and Takelma (Sapir 1912, pp. 45–46) among others. However, the existence of these patterns per se is not direct evidence that dissimilation in prenasalization is phonetically natural because dissimilation in voicing is arguably phonetically unnatural, but it does exist. To the extent that these patterns spontaneously emerged—as does devoicing of voiced geminates in Japanese loanword phonology—they do provide evidence for phonetic naturalness of dissimilation in nasalization.

[7] Prenasalization may be more vulnerable to perceptual confusion than full nasal segments. Prenasalized segments have an oral release, and thus to cue nasality, spread nasalization in preceding vowels should play a more important role for prenasalized segments than for full nasal segments.

2005). In sum, OCP(voi) in Modern Japanese originated as OCP(prenas) in Old Japanese, which was a phonetically natural constraint. However, when the prenasalization contrast became a voicing contrast, OCP(prenas) was divorced from its original natural phonetic motivation. Configurations with two voiced consonants, since they have no robust spread-out cues, do not present a perceptual confusability problem in the way that two prenasalized consonants do.

5.3 Cross-linguistic look at OCP(voi)

As discussed above, Japanese OCP(voi) originated as OCP(presnas), a phonetically natural constraint. Then what about other cases of voicing dissimilation? Beyond Japanese, two cases of voicing dissimilation are known, but they also originated as a phonetically natural dissimilative requirement on a property other than voicing, or from a natural but non-dissimilative pattern (Ohala 1981, 1993).

First, Dahl's Law in Bantu languages dissimilates [k] into [ɣ] before a voiceless consonant separated by a vowel. However, Bennett (1967, p. 155) compares several languages and dialects which exhibit Dahl's Law and concludes that it should have originated from ''a loss of aspiration by the first of two voiceless and aspirated stops''. In other words, dissimilation of voicelessness originated as the dissimilation of aspiration. Aspiration involves spread-out acoustic correlates like breathy voicing of surrounding vowels, and therefore dissimilation would resolve multiple occurrences of aspirated consonants. Bennett's hypothesis also explains why only velars dissimilate: velars have longer aspiration than consonants at other places of articulation (Maddieson 1997) and are thus most likely to cause perceptual confusion. The dissimilation of aspiration is thus the phonetically natural ancestor of dissimilation of voicing in these Bantu languages.

Second, in Gothic, fricatives dissimilate in voicing from a preceding consonant (Thurneysen's Law: Thurneysen 1897). However, the dissimilation in voicing may have derived from the prosodic-conditioned alternation in Proto-Germanic. A general voicing process of fricatives (Verner's Law: Verner 1875/1967) was blocked by a preceding accented syllable, and since Proto-Germanic had a mobile accent system, this voicing pattern historically resulted in an apparently dissimilative pattern (Flickinger 1981; Ohala 1981; see also Garrett 2007 for a recent summary of previous treatments of Thurneysen's Law as well as a slightly different perspective). In short, the dissimilation in voicing in Gothic derived from a non-dissimilative pattern.

To summarize, all three cases of voicing dissimilation, including that of Japanese, originated as a phonetically natural dissimilative requirement on properties other than voicing, or from a natural but non-dissimilative pattern.[8]

[8] Proto-Indo European turns up in discussions about voicing dissimilation (Meillet 1964), but the consonants in question may have been glottalized rather than voiced (Hopper 1973). If the consonants were voiced rather than glottalized, the system would be an otherwise poorly attested one which has [d] and [g], but lacks [b] (Ohala 1983). Regarding the series as voiceless glottalized consonants results in a more natural system since the lack of voiceless glottalized labials is typologically common. Glottalization involves spread-out cues through creakiness of surrounding vowels, so glottalization would naturally be subject to dissimilation.

6 General discussion and conclusion

In Japanese loanword phonology, only voiced geminates devoice due to OCP(voi). The different devoicability between singletons and geminates has a natural perceptual basis whereas the unnatural principle of OCP(voi) originated from a coincidental historical development.

The phonetically natural ranking $\textsc{Ident}(\text{voi})_{\text{Sing}}$ » $\textsc{Ident}(\text{voi})_{\text{Gem}}$ interacts with the phonetically unnatural OCP(voi) constraint. Therefore, a single grammatical system can have phonetically natural and phonetically unnatural aspects.[9]

Nevertheless, echoing the insight of Stampe (1973) and Hooper (1976, pp. 84–86), I argue that phonetic naturalness and unnaturalness are asymmetric. Natural patterns arise in the absence of positive phonological evidence whereas unnatural patterns do not. In Japanese loanword phonology, devoicability has been determined by a perceptibility scale without any overt phonological evidence. On the other hand, OCP(voi) arose as a coincidental historical development in Japanese as well as in other languages. In fact, all other phonetically unnatural patterns discussed in the literature, beyond OCP restrictions, have developed as a result of sound changes (Anderson 1981; Bach and Harms 1972; Blevins 2004).

Phonetically unnatural constraints—or constraints that do not have phonetic seeds—do not seem to spontaneously emerge as novel phonological patterns but only appear as developments of historical changes. The limited origin of phonetically unnatural patterns, such as OCP(voi), needs to be explained. I propose that speakers—or UG—possess phonetically natural constraints even without overt phonological evidence, but phonetically unnatural constraints are constructed only when confronted with overt evidence (Hayes 1999; see also Stampe 1973 for a similar idea).

The present proposal makes predictions that should be tested in future studies. If the universal set of phonological restrictions is phonetically natural, emergent novel phonological patterns should *always* be phonetically natural because diachronic changes cannot influence them. The prediction has been borne out in a novel devoicing pattern in Japanese loanword phonology, as discussed in Sect. 4 (see also Zuraw 2007 for another pattern). Another domain in which the emergence of phonetic naturalness has been documented is verbal art patterns such as English and Japanese imperfect puns (Fleischhacker 2005; Kawahara and Shinohara 2009) and Japanese rap rhyming (Kawahara 2007). Although these cases suggest that emergent phonological patterns tend to be phonetically natural, the possible phonetic bias of phonological grammars should be tested in wider context.

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[9] The interaction of these three constraints implies another point. OCP(voi) shows a number of morphophonological characteristics (e.g., its domain is a morphological stem). The fact that OCP(voi) interacts with the phonetically-based ranking, $\textsc{Ident}(\text{voi})_{\text{Sing}}$ » $\textsc{Ident}(\text{voi})_{\text{Gem}}$, suggests that phonetic information can influence morphophonological patterns. This conclusion should be contrasted with a claim made in Lexical Phonology that morphophonological lexical processes should be separated out from more automatic post-lexical rules that resemble phonetic implementation rules (Kiparsky 1985).

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