On a Certain Type of Hiatus Resolution in Japanese*

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Abstract: This paper discusses one type of hiatus resolution in Japanese, which spreads the first vowel to the second syllable node in hiatus. This phenomenon has not been hitherto systematically investigated, and thus the first aim of this paper is to provide a detailed descriptive characterization of several aspects of this phenomenon. The second aim is to analyze this alternation from perspectives of current phonological theory and consider its theoretical implications. Most importantly, I argue that the phenomenon supports the postulation of CRISP-EDGE constraints and further argues for their extension to morphological categories.

Keywords: hiatus resolution, spreading, alignment, CRISP-EDGE, Derived Environment Effect.

1. Introduction

This paper discusses a certain type of hiatus resolution in Japanese, which has hitherto received no comprehensive treatment. The first goal of this paper is thus descriptive: it aims to provide a detailed characterization of several aspects of the hiatus resolution strategy. The second goal is to consider through the analysis of this phenomenon the formal properties of autosegmental spreading, alignment (McCarthy and Prince 1993), and crispness of category edges (Ito and Mester 1994, 1999) from the perspective of Optimality Theory (Prince and Smolensky 1993). First, the analysis proposed in this paper supports the revised way of computing alignment violations by Ito and Mester (1994) over the original proposal by McCarthy and Prince (1993). Second, the phenomenon provides additional support to the postulation of CRISP-EDGE constraints (Ito and Mester 1994, 1999) within *Con* and, furthermore, requires the extension of this constraint family. Third, I present two puzzling problems: (i) unexpected situations in which hiatus resolution mysteriously fails to apply and (ii) a Derived Environment Effect puzzle where identical derived and underlying sequences undergo different strategies to avoid hiatus. I present tentative solutions to these problems, but I also point out that they are not explanatory enough. I conclude that these two problems warrant further investigation.

2. Description

The data in (1) illustrates the hiatus resolution strategy that is the subject of this paper. Two consecutive vowels are optionally split by an intervening glide, which agrees with the first vowel in backness i.e., [w] appears after [o] and [u], and [j] appears after [i] and [e].

(1) /ia/ => [i**j**a]: *dai[j]a* 'diamond,' *pi[j]ano* 'piano,' *si[j]awase* 'happiness,' *sai[j]aku* 'worst'
/io/ => [i**j**o]: *i[j]on* 'ion,' *ohai[j]o* 'Ohio,' *oni[j]on* 'onion,' *rai[j]on* 'lion'
/ea/ => [e**j**a]: *he[j]a* 'hair,' *pe[j]a* 'pair,' *ohe[j]a* 'O'hare,' *e[j]akon* 'air conditioner'
/ua/ => [u**w**a]: *gu[w]ai* 'condition,' *karuu[w]a* 'kahlua,' *hu[w]an* 'worry'
/oa/=> [o**w**a]: *do[w]a* 'door,' *ro[w]a* 'ROA,' *o[w]asisu* 'oasis,' *ko[w]ara* 'koala'

The phenomenon demonstrated above can be described as the creation of glides homorganic to the first vowel in hiatus (see Rosenthall 1994; Cohn and McCarthy 1994; Booij 1995; Pater 2001 for similar phenomena in other languages). The environments listed above are all of those where the hiatus breaking actually takes place; not all vowel sequences undergo this type of glide formation, and there are four types of environments in which glides are not formed. The first one is where two vowels constitute a long vowel or a diphthong. The second case is when the first vowel is [a][1], where its high sonority prevents it from triggering glide formation (see Rosenthall 1994). The third case is where a co-occurrence restriction against glides with tautosyllabic vowels is enforced. In Japanese, there is an OCP-like effect (see McCarthy 1986) where [w] can only co-occur with [a] (i.e., *wi, *wu, *we, *wo) and [j] can only co-occur with non-front vowels (i.e., *je and *ji). These restrictions are respected in the context of this glide formation too, as seen in (2)[2]. The fourth case is unexpected gaps [eo], [eu] and [iu] where glide formation mysteriously fails. This case is discussed more in section 4.

(2)	*i[j]e	'house'	*ki[j]eru	'extinguish'
	*chuu[w]i	'attention'	*to[w]i	'quesions'
	*u[w]e	'above'	*o[w]eru	'finish'
	*u[w]o	'fish'	*ko[w]u	'this way'

The table below summarizes the distribution of the glides. Shaded cells represent where a glide is not created. There is sometimes more than one reason why a glide is not created; e.g., given /oi/, the would-be resulting structure [owi] deviates from the Japanese phonotactics, and so it is banned. In addition, this underlying sequence is likely to constitute a diphthong at the surface, so cross-syllabic spreading is in principle impossible. In such cases, I only just list one of the reasons. Finally, cells with a question mark stand for unexpected gaps (see section 4 for more discussion on these gaps).

(3) Summary Table

V1 \ V2	i	u	e	o	a
i	Long Vowel	?	Phonotactics	[ijo]	[ija]
u	Phonotactics	Long Vowel	Phonotactics	Phonotactics	[uwa]
e	Diphthong	?	Long Vowel	?	[eja]
o	Phonotactics	Phonotactics	Phonotactics	Long Vowel	[owa]
a	Non Trigger	Non Trigger	Non Trigger	Non Trigger	Long Vowel

Let us now look at some other properties of this glide formation. First of all, the creation of a glide is optional, and some people feel that the insertion of glides is sporadic. However, in spontaneous speech, this alternation is highly productive, and only in extremely careful speech can glides not appear. Moreover, people are able to give categorical judgments as to whether a particular resulting structure is well-formed or not. For example, most Japanese people agree that *i[j]a* sounds grammatical while *e[j]o* does not. Finally, we find indirect evidence in the fact that people sometimes confuse the orthographic representation of [ia] with that of [ija], and vice versa. This can be explained if we assume that these two sequences can be actively neutralized. Hence, for these reasons suggested above, it seems safe to conclude that this alternation is active in the phonology of Japanese. It is also worth pointing out that the placement of accent is irrelevant to this process. Both accented and unaccented vowels can trigger the glide formation, as instantiated by dó[w]a 'door' and pi[j]ano (an unaccented word) 'piano.' Another interesting aspect of this glide formation is that morphological and syntactic boundaries usually block the hiatus breaking:

(4) Interference by Morphological Boundaries

*?de+[j]au	'encounter'	(cf., he[j]a	'hair')
*?mushi+[j]atsui	'humid'	(cf., pi[j]ano	'piano')
*haru+natsu+[w]aki+huyu	'spring, summer, autumn, winter'		
		(cf., hu[w]an	'worry')
*umoo+[w]atsume	'wool hunting'	(cf., do[w]a	'door')

Interference by Syntactic Boundaries

*?suzusii [j]asa	'cool morning'	(cf., pi[j]ano	'piano')
*oite [j]aru	'left'	(cf., he[j]a	'hair')
*?sonkee dekiru [w]aite	'the trustable partner'	(cf., hu[w]an	'worry')
*arito [w]arahuru	'every kind of'	(cf., do[w]a	'door')

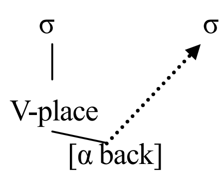
One might argue that some complex words do allow glide formation across a putative morphological boundary, as in examples like *hu+[w]an* 'worry' and *gu+[w]ai* 'condition.' In those cases, however, the morphological boundaries are likely to be synchronically absent.

Before closing this section, there is one more important issue to be addressed: is the phenomenon phonological or phonetic? Are glides created by this process are phonologically real or are they simply automatic articulatory effects of the vowel sequences? Future phonetic experimentation is called for to settle this issue. However, I will tentatively suggest that the phenomenon is phonological for the following reasons. First, recall that morphological and syntactic boundaries actively block the formation of glides; if the glides are nothing more than automatic phonetic effects, this blockage is inexplicable. Second, recall that OCP-violating sequences such as [je] and [ji] are not allowed to surface. The fact that the process is blocked by a phonological principle such as the OCP indicates that the process is indeed phonological. Third, note that a high back vowel in Japanese is phonetically unrounded (i.e., [ɯ]), so a rounded [w] created by this vowel cannot be simply phonetic. Finally, the presence of the unexpected gaps cannot be explained if the overall process is phonetic, because there are no obvious phonetic reasons that the sequences fail to undergo glide formation.

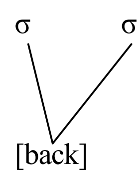
3. Analysis: Spreading, alignment, and CRISP-EDGE

This section analyzes the data presented above. Special attention will be given to the issues surrounding spreading, alignment and crispness of category edges within the framework of Optimality Theory (OT; Prince and Smolensky 1993). Before going into the main discussion, we need to make clear what kind of phonological operation (1) actually involves. The phenomenon is best understood as spreading of the [back] feature of the first vowel in hiatus to the second syllable node. This captures the fact that the value of the emergent glides depends completely on the backness specification of the trigger. (Highness is irrelevant, as mid vowels create high glides.)

(5)



(6)



One question regarding (5) is how other necessary features for the resulting glides, such as [+high], [+sonorant] and [+continuant], are derived if only [αback] feature spreads. I assume that the interpolation of these features takes place in the phonetic component in Japanese wherein a vocalic [+back] that is directly dominated by a syllable node is interpreted as [w] and, similarly, [-back] as [j]. This explains why an unrounded back vowel can create a rounded glide: a vocalic [+back] feature is interpreted as a rounded glide when linked to a non-moraic position.

Let us now move on to an OT analysis. Two significant questions that should be kept in mind are: (i) why Japanese chooses (5) as a hiatus resolution strategy rather than deletion or epenthesis and (ii) why there are some languages that do not appeal to (5) to resolve hiatus. OT answers these questions by hypothesizing that languages differ in their rankings of the universal set of constraints. The constraints listed below are relevant in this context:

(7) ONSET: A syllable starts with a consonant.
MAX: Every element in the input must have a correspondent in the output.
DEP: Every element in the output must have a correspondent in the input.
CRISP-EDGE(σ): Every phonological element uniquely belongs to one syllable.

CRISP-EDGE family of constraints was first proposed by Ito and Mester (1994), and its importance is supported below (see Ito and Mester 1994 for a more formal definition; See also Noske 1997; Ito and Mester 1999; Walker 1999, 2001; Kawasaki 2000; Pater 2001; Pineros 2002; Kawahara in prep; and others). Consider the resulting structure of (5), represented as (6), where the [back] feature belongs to two syllables. The structure violates CRISP-EDGE(σ), and this violation is how the markedness of (6) is formally expressed[3]. The reason why some languages do not appeal to (5) is that in such languages CRISP-EDGE(σ) is ranked higher. Japanese employs (5) because CRISP-EDGE(σ) is ranked the lowest of the constraints listed in (7), as the tableau below illustrates:

(8)

/daia/	Max	Dep	Onset	Crisp-Edge(σ)
a. [dai.a]			*!	
b.☞[dai.ja]				*
c. [dai.ʔa]		*!		
d. [dai]	*!			

The use of Crisp-Edge constraints receives additional empirical support from the fact that the formation of glides is blocked by morphological and syntactic boundaries. Consider the two structures below, taking [de+au] 'encounter' as an example. Following McCarthy's (1979) convention, phonological elements are associated with a morpheme (here represented as $\mathbb{M}$) with an autosegmental line.

(9) a. <u>Non-Crisp Morpheme Edge</u> b. <u>Crisp Morpheme Edge</u>

a.
$\mathbb{M}$ $\mathbb{M}$
de au

b.
$\mathbb{M}$ $\mathbb{M}$
de au

In (9a), the [back] feature of [e] is associated with both morphemes; hence it is morphologically non-crisp[4]. The fact that such a structure is illicit can easily be accounted for by extending Crisp-Edge constraints to morphological categories, namely, Crisp-Edge($\mathbb{M}$), which requires every phonological element to uniquely belong to one morpheme. The blockage by a syntactic boundary can be also explained by Crisp-Edge($\mathbb{M}$), since the presence of a syntactic boundary entails the existence of a morphological boundary. Importantly, Crisp-Edge(σ) and Crisp-Edge($\mathbb{M}$) can be ranked separately: the former is violated under the duress of Onset while the latter is not, hence motivating Crisp-Edge($\mathbb{M}$)>> Onset >> Crisp-Edge(σ).

One might attempt to block spreading by positing some prosodic boundary that coincides with a morphological and syntactic boundary. This, however, lacks any independent support. First, the fact that almost all compounds have only one accent (modulo so-called *Aoyagi-compounds*) suggests that compounds are composed of only one prosodic word. Thus, it is impossible to postulate a prosodic word boundary within a compound. Second, a foot boundary is also difficult to motivate in such cases since for most lexical words, the presence and placement of a foot is hard to detect in Japanese. There is no independent reason that a morphological boundary would always coincide with a foot boundary. Finally, if spreading were blocked by a foot boundary, the blocking should have also been observed word-internally, yet such word-internal blocking is not attested. From these considerations, I conclude that the reference to a morphological category is necessary.

The extension of Crisp-Edge constraints to morphological categories does in fact have wide cross-linguistic applicability. For example, they can be utilized to account for the common prohibition against making true geminates across a morphological boundary (see e.g., Schein and Steriade 1986). See Kawahara (in prep.) for extensive discussion of this point and more examples.

To summarize this section so far, in order to express the markedness of (6), I propose utilizing CRISP-EDGE(σ). With this constraint ranked below all the others, Japanese breaks hiatus by way of inter-syllabic spreading. The fact that spreading is blocked by morphological and syntactic boundaries is explained by the high-ranked CRISP-EDGE(𝕄).

Now let us move on to a discussion of how alignment constraint violations are to be computed. It has been proposed that ONSET can be also framed as ALIGN-L(σ, C) that forces the presence of a consonant at the left edge of each syllable (McCarthy and Prince 1993; Ito and Mester 1994, 1999). With this in mind, consider again the structure (6). The question is whether ALIGN-L(σ, C) is satisfied or not in the second syllable. It might seem that alignment constraints in such structures are violated because of the multiple linking. This is in fact the case under the original proposal by McCarthy and Prince (1993). Ito and Mester (1994), however, proposed that alignment proper is to be distinguished from crisp-edgeness. In the case at hand, ALIGN-L(σ, C) must count as satisfied because the spreading takes place to avoid a violation this constraint. Therefore, to the extent that ONSET can be indeed translated into an alignment constraint, it lends a further support to the revision by Ito and Mester (1994) (see Merchant 1994; Cohn and McCarthy 1994 for a similar view).

4. Two puzzles

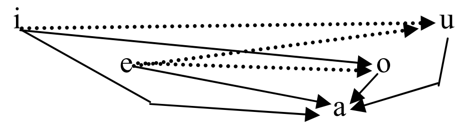
Building upon the basic analysis presented above, this section presents two remaining issues. The first is the unexpected gaps, in which glide formation fails for no apparent reason. The second is Derived Environment Effect in which derived and non-derived sequences undergo different kinds of hiatus resolution.

Let us start with the first problem. As shown in (10), the sequence of [eo] and [eu] resist glide formation; [iu] undergoes a different kind of (morphologically conditioned) glide formation, becoming into [juu] (e.g., Poser 1986). This resistance of the former sequences is surprising as [e] and [i] are legitimate triggers and [jo] and [ju] are licit sequences in Japanese.

(10) /eo/ => *[ejo]: **mete[j]o* 'meteor,' **ne[j]o* 'neo-,' **ne[j]on* sain 'neon,'
/eu/ => *[eju]: **ke[j]u* 'rare,' **see[j]uchi* 'see lion,' **me[j]ue* 'older people'
/iu/ => *[iju]: /iu/ => [juu] *[iju] 'say,' **umi[j]+ushi*, **umjuushi* 'a sea animal'

A descriptive generalization concerning the distribution of these gaps is fairly straightforward. Consider the vowel space, provided in (11). Solid lines represent those sequences which give rise to glide formation, and dotted lines represent those where the gaps occur. Notice that the gaps arise when the height rises or stays even between the first vowel and the second. Based upon this, I had previously suggested that these gaps might arise because the sequences constitute diphthongs. However, as pointed out by Kubozono Haruo (p.c.), this contradicts evidence from accent placement. Moreover, examples such as *seeuchi* pose a further problem in that we would have to say that [eeu] belongs to one syllable (thanks to Tateichi Koichi for pointing this out to me). Thus, explaining the gaps in terms of syllable structure is untenable. However, since I cannot come up with a good solution to this problem, I would like to leave it as a future research topic.

(11)



The second remaining problem is a kind of Derived Environment Effect. In short, derived and non-derived environments undergo different kinds of glide formation. Consider the data below, which illustrates hiatus resolution in derived environments (e.g., Poser 1986).

(12) owa => oa => aa :	*chitt****o****+****wa*** => *chitt****aa***	‘little+par’
	*soitsu+t****o****+****wa*** => *soitsut****aa***	‘that guy with+part.’
uwa => ua => aa:	*soits****u****+****wa*** => *koits****aa***	‘that is’
	*akak****u****+****wa*** => *akak****aa***	‘red+part’

(13) eba => ea => jaa:	***reba*** => *r****jaa***	‘if…’
	*hak****e****+****ba*** => *hak****jaa***	‘if throw up’
ewa =>ea => jaa:	*tott****e****+****wa*** => *tott****jaa***	‘for+part.’
	*kotod****ewa*** => *kotod****jaa***	‘not that’
iwa => ia => jaa:	*kocch****i****+****wa*** => *kocch****jaa***	‘this side+ part.’
	*toki+n****i****+****wa***=> *toki****njaa***	‘from time to time’

As shown above, labial consonants flanked by a vowel and [a] delete, and the resulting hiatus is resolved either by regressive assimilation when the first vowel is back, as in (12) or by glide formation, which is different in kind from (1), when the first vowel is front, as in (13). In neither case does cross-syllabic spreading take place.

This discrepancy between derived and non-derived sequences poses a recalcitrant problem for the standard surface-oriented OT, because the reference to derivational history is prohibited. McCarthy (2002) suggests that markedness constraints be split into two types: those that militate against marked structures that are present in underlying structures (M<old>) and those that militate against creating new marked structures (M<new>). This theory provides a solution to a traditional derived environment problem in which only derived sequences undergo phonological alternations. The fact that new marked structures are avoided while old structures are tolerated can be explained by the ranking M<new> >> FAITH >> M<old>. This approach, however, does not work for the case at hand. Notice that the Japanese data are such that both derived and underlying structures undergo an alternation; however, different strategies are used in each case. Hence simply splitting markedness constraints is not sufficient.

Another approach for deriving Derived Environment Effect has been proposed by Lubowicz (2002). Her analysis crucially relies on local conjunction of constraints (Smolensky 1995), which allows low ranked constraints to "gang up" to be ranked higher when they are conjoined. Suppose that constraint A and constraint B are conjoined within a certain domain D as $(A\&B)_D$, this conjoined constraint is violated iff both constraints are simultaneously violated in D. To illustrate, let us take the contrast between (1) and (13) and let us say, for the sake of illustration, that a constraint violated by (13) is FAITH-X. Consider now the summary table below:

(14)	Strategy	Constraint Violated
Non-Derived	Spreading	CRISP-EDGE(σ)
Derived	Glide formation	FAITH-X

The local conjunction approach would account for the presence of the two strategies as follows. Since CRISP-EDGE(σ) is ranked lowest, it is the constraint violated in non-derived environments. However, suppose that this constraint is conjoined with MAX within the domain of a prosodic word, resulting in it being ranked higher than Faith-X, deletion and spreading cannot take place simultaneously. As a result, FAITH-X is disregarded in derived environments.

(15) Non-Derived Environment

/hea/	$\{*\text{CRISP-EDGE}(\sigma)\&\text{MAX}\}_{\text{PRWD}}$	ONSET	FAITH-X	CRISP-EDGE(σ)	MAX
a. [hea]		*!			
b.☞ [heja]				*	
c. [hjaa]			*!		

(16) Derived Environment

/-reba/	$\{*\text{CRISP-EDGE}(\sigma)\&\text{MAX}\}_{\text{PRWD}}$	ONSET	FAITH-X	CRISP-EDGE(σ)	MAX
a. [rea]		*!			*
b. [reja]	*!			*	*
c.☞ [rjaa]			*		*

This approach does successfully account for the data. Crucially, however, this approach is not at all explanatory (see also Padgett 2002 for a general criticism against local conjunction). It does not provide any insight as to why identical derived and non-derived sequences take different hiatus-resolving strategies. The contrast is, according to this approach, nothing more than an epiphenomenal result of the haphazard conjunction of constraints. With this said, however, I cannot come up with a better analysis, and therefore a better solution is called for in future investigations.

5. Concluding remarks

To briefly recapitulate what has been discussed in this paper. I first provided a detailed description of one type of hiatus resolution in Japanese. When particular conditions are met, the [back] feature of the first vowel in hiatus spreads to the second syllable node, resulting in an intervening glide. Alignment constraints must be satisfied in these cases of multiple linking, as first argued by Ito and Mester (1994). Moreover, CRISP-EDGE constraints are necessary to formally express the markedness of the resulting structure, and to account for the blocking of the spreading by morphological boundaries. In section 4, I pointed out two puzzling problems, both of which require further investigation. Finally, I strongly hope that this paper initiates further investigations of this type of hiatus resolution in Japanese, from both descriptive and theoretical perspectives.

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Notes

* I am grateful to Takeru Honma, Kazutaka Kurisu, Haruo Kubozono, John McCarthy and Kohei Nishimura for valuable comments that led to much improvement of this paper. Thanks are also due to Kathryn Flack for her last minute proofreading. Any errors are my responsibility.

[1] There is one systematic exception: [Ca+ai] => [Cawai], as exemplified by *ma[w]ai* 'distance,' *ta[w]ai* 'effort,' *ba[w]ai* 'case' and others.

[2] Admittedly, it is possible that people do not hear glides in this context because the grammar of Japanese does not allow glides in such positions i.e., the grammar of Japanese might be interfering people's perception. A phonetic experiment is called for to settle this issue.

[3]It is insufficient to use a faithfulness constraint such as *SPREAD (as formalized, for example, in McCarthy 2000) to crucially penalize structure (6), as some languages absolutely prohibit such surface structures. This must be the result of a markedness constraint, assuming the Richness of the Base (Prince and Smolensky 1993 and others). See Kawahara (in prep.) for concrete examples of such systems and more on the inadequacy of the *SPREAD constraint

[4] What is penalized by CRISP-EDGE($\mathbb{M}$) is a structure like [de]#[jau], in which the [back] feature of [e] belongs to both of the morphemes. Structures like [dej]#[au] or [de]#j[au], I assume, are independently ruled out by an alignment constraint that requires the left edge of an morpheme to be aligned with a left edge of a syllable.

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