Vocalization and Intrusion of *r* in English*

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1. Introduction

Deletion and insertion of *r* in some dialects of English have been dealt with by many researchers.[1] For example, McCarthy (1993) analyzed *r*-deletion and *r*-insertion of Eastern Massachusetts English in terms of Optimality Theory (Prince and Smolensky 1993; henceforth, OT). Recently, Halle and Idsardi (1997) criticized McCarthy's OT account in favor of a rule-based analysis. They pointed out two non-trivial problems in McCarthy's OT account. One is the arbitrariness of *r*-intrusion, that is, why only *r*s, not others, are inserted after *a*, *ɔ*, and *ə*. The other is the opacity problem resulting from the interaction of schwa insertion and *r*-deletion. If schwa insertion takes place between a high glide and a coda *r*, and then the coda *r* is deleted, the result of applying these processes to the word *fear* /fijr/ will be [fijə]. In this form, the schwa insertion rule becomes opaque since there remains no surface environment for this rule. Such an opacity problem has been considered to be problematic in the standard OT that is surface-oriented. The primary aim of this article is to provide a unified way of resolving the above two problems.

The rest of this article is organized as follows. In section 2, relevant data and issues are presented. In the next section, McCarthy's (1993) original OT analysis and its problems are presented, following Halle and Idsardi (1997). In section 4, an alternative analysis of *r* is introduced, in which *r*-deletion is treated as *r*-vocalization (weakening) and *r*-insertion as glide insertion. Based on these assumptions, a new OT analysis is proposed in section 5. Section 6 concludes the article.

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[1] Throughout the article, *r* represents the English rhotic phoneme [ɹ], whose phonetic quality is discussed in some detail in section 4.

In this article, many aspects of *r* (e.g., the effects of *r* on the preceding vowels, historical change, and dialectal variations, etc.) are ignored, since the focus of the article is on the Eastern Massachusetts dialect as presented in McCarthy (1991, 1993) and Halle and Idsardi (1997). Historical change and dialectal variations will be dealt with in Hwangbo (1999).

2. Data and Issues

The *r*-related phenomena in Eastern Massachusetts English are described in detail in McCarthy (1991, 1993) and Halle and Idsardi (1997; henceforth H&I). Relevant examples are illustrated below (McCarthy 1993: 170):

	a.	b.
(1)	*r*-deletion	*r*-linking
	The spa~~r~~ seems to be broken.	The spar is broken.
	He put the tun<u>e~~r~~</u> down.	He put the tun<u>er</u> away.
	You'~~r~~e somewhat older.	You're a little older.
(2)		*r*-intrusion
	The spa seems to be broken.	The spaʳ is broken.
	He put the t<u>una</u> down.	He put the tun<u>aʳ</u> away.
	The boat tends to yaw some.	The boat'll yawʳ a little.

In this dialect, *r* is not pronounced before a consonant or a pause, as in (1a); however, it is pronounced before a vowel, as in (1b). In the latter case, the *r* is called **linking *r***. Interestingly, *r* is inserted before a vowel, even though there is no *r* in the spelling (or in the input), as in (2b). This *r* is referred to as **intrusive *r***. Intrusive *r* takes place typically after *ɑ*, *ɔ*, and *ə*.[2] Intrusive *r* can also occur word-internally, as in *drawʳing* and *sawʳing*.

As mentioned in section 1, intrusive *r* poses a difficult problem because of its apparent arbitrariness. McCarthy (1993: 190-191), for example, did not show why *r*, rather than others, is inserted after *ɑ*, *ɔ*, and *ə*. He just assumed that *r* is inserted by a special rule of *r*-insertion, which is outside the system of Optimality. The problem of this proposal has already been

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[2] Intrusive *r* may also occur after *æ* and *ε*, but only marginally, as in *baaing* [bæːʳɪŋ] (Donegan 1993: 118~9) and *yeah it is* [jεːʳɪtɪz] (Broadbent 1991: 295, Wells 1982: 226). See also Hwangbo (1998: 294).

pointed out by H & I, as will be seen in section 3.

The second problem of McCarthy's analysis is related to the interaction between schwa insertion and *r*-deletion. Schwa is inserted between diphthongs ending in high glides on the one hand, and *r* and *l* on the other hand, as illustrated below (McCarthy 1991).[3] Note, however, that final-*r*s are deleted afterwards while final-*l*s are not.

(3) a. **Schwa insertion before *l***

feel	[fijəl]	fool	[fuwəl]
fail	[fejəl]	foal	[fowəl]
file	[fɑjəl]	foul	[fɑwəl]
foil	[fojəl]		

b. **Schwa insertion before *r***

fear	[fijə]	sure	[šuwə]
pare	[pejə]	four	[fowə]
fire	[fɑjə]	flour	[flɑwə]

In rule-based approaches, these processes do not seem to raise any problem, since schwa insertion followed by *r*-deletion will produce correct results:

(4)

UR	fijl	fijr
schwa insertion	fijəl	fijər
r-deletion	-----	fijə
SR	fijəl	fijə

Since there do not remain any surface environments for schwa insertion after *r* has been deleted, we cannot find any reason that forces a schwa to appear in the output form. In other words, *r*-deletion causes non-surface-apparent opacity (McCarthy 1998). However, accounting for these processes in OT would be problematic since OT does not allow any derivations and just relies on surface-oriented constraints, as pointed out by H & I (pp. 340 ~2).[4]

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[3] I will argue in section 4 below that the epenthetic vowels before *l* are slightly different from those before *r*, in that epenthetic vowels before *l* are rather *ʊ*-like while those before *r* are rather *ɑ*-like.

[4] McCarthy (1998) and others have been trying to solve opacity problems by a new mechanism called sympathy. In this article it does not matter whether the sym-

Besides the two fundamental problems (arbitrariness of *r*-intrusion and the opacity problem) mentioned above, we find that McCarthy (1993) and H&I have different views on the following matters. The first concerns schwa insertion. McCarthy (1991) argues that schwa insertion does not take place when the following morpheme begins with a vowel, as in (5):

(5)	a.	feeling	[fijlɪŋ]	feel it	[fijlɪt]
		failing	[fejlɪŋ]	fail it	[fejlɪt]
		filing	[fɑjlɪŋ]	file it	[fɑjlɪt]
		fooling	[fuwlɪŋ]	fool it	[fuwlɪt]
		goalie	[gowlij]	goal of	[gowləv]
	b.	rearing	[rijrɪŋ]	rear of	[rijrəv]
		paring	[pejrɪŋ]	pare it	[pejrɪt]
		firing	[fɑjrɪŋ]	fire it	[fɑjrɪt]
		assuring	[əšuwrɪŋ]	assure it	[əšuwrɪt]

He also notes that in 'more monitored speech,' schwa epenthesis takes place even when the following morpheme begins with a vowel, as in (6):

(6)	a.	feeling	[fijəlɪŋ]	feel it	[fijəlɪt]
		filing	[fɑjəlɪŋ]	file it	[fɑjəlɪt]
		fooling	[fuwəlɪŋ]	fool it	[fuwəlɪt]
	b.	rearing	[rijərɪŋ]	rear of	[rijərəv]
		firing	[fɑjərɪŋ]	fire it	[fɑjərɪt]
		assuring	[əšuwərɪŋ]	assure it	[əšuwərɪt]

By contrast, H & I (p. 333, fn. 2) argue that the pronunciations in (6) are normal with many speakers.

The next issue concerns how to represent phonetic differences of *r*s. McCarthy (1993: 178-179) argues that linking and intrusive *r*s are of the same quality and distinct from true word-initial *r*s. For example, the *r* in *saw^r eels* [sɔɪ ijlz] is considerably more vocalic than the *r* in *saw reels* [sɔ rijlz].[5] Accordingly, McCarthy claims that this phonetic distinction should be reflected in the representations. H&I agree on this fact, adding that the

pathetic approach is right or not since it will be argued in section 4 that there arises no opacity problem in explaining English *r*-phenomena.

[5] Similar arguments are also found in Gimson (1989: 304, 1994: 264).

allophones of *l* must also be treated in the same way. Yet, their approach is different from McCarthy's. McCarthy claims that more vocalic *r*s are ambisyllabic. On the other hand, H&I assume that McCarthy's ambisyllabic *r*s must be treated as coda *r*s (H&I 334, fn. 7), and that resyllabification across the word boundary must be prohibited in order to keep *r* (and *l*) in coda position (p. 343).

The final issue to be considered is why *r*-intrusion follows *r*-loss historically. This fact has been regarded as part of evidence for rejecting the claim that *r*-intrusion is a natural context-sensitive phenomenon. McCarthy (1991) argues that the apparent addition of *r*-insertion rule ($\varnothing \rightarrow$r) is in fact a natural consequence of rule generalization in which deletion rule (r$\rightarrow \varnothing$) becomes a synchronic inversion rule (r$\sim \varnothing$). On the other hand, H&I claims that the addition of insertion rule is by hypercorrection, and that the rule ordering is determined by their Revised Elsewhere Condition. This issue will not be addressed in this article, but in a separate article (Hwangbo 1999).

3. McCarthy's Analysis of *r* and its Weakness

McCarthy (1993) is the first to propose an OT analysis of *r*-insertion and *r*-deletion in English. The crucial constraints relevant to *r*-deletion and *r*-insertion are *Cod/r[6] and Final-C, which are defined below:

(7) a. *Cod/r: No *r* should be wholly within a syllable coda (H&I: 337; McCarthy 1993).

b. Final-C: Every word must end with (part of) a consonant (H&I: 337; McCarthy 1993).

Here, for convenience, the definition of *Cod/r is provided explicitly in a crisp manner and Final-C in a non-crisp manner, following H&I (cf. Itô and Mester 1994). It is important to realize that *Cod/r and Final-C are satisfied by ambisyllabic *r*s. Consider first *r*-deletion:

[6] McCarthy uses the term Coda-Cond instead of *Cod/r.

(8)

	*Cod/r	Final-C
σ σ σ ☞ Ho me~~r~~ left ☞ Wan da left		*
σ σ σ Ho mer left Wan da^r left	*!	

The candidates *Home~~r~~ left / Wanda left* obey the dominant constraint *Cod/r, whereas the candidates *Homer left / Wanda^r left* violate it. Consequently, *Home~~r~~ left / Wanda left* are selected as the optimal forms. Next, consider the examples where linking or intrusive *r* occurs :

(9)

	*Cod/r	Final-C
σ σ σ σ Ho me~~r~~ a rrived Wan da a rrived		*!
σ σ σ σ ☞ Ho mer a rrived ☞ Wan da^r a rrived		

Recall that *Homer arrived / Wanda^r arrived* obey the constraint *Cod/r since the junctural *r* is ambisyllabic. Thus, the candidates *Home~~r~~ arrived / Wanda arrived* and *Homer arrived / Wanda^r arrived* all obey the constraint *Cod/r. This tie is resolved in the usual way, by passing the candidates on to the rest of constraint hierarchy, in this case Final-C.

Tableau (9) shows that intrusive *r* satisfies both *Cod/r and Final-C. However, the important question that we must ask here is why *r* is inserted in this position. We cannot have recourse to the epenthesis of a default consonant, since *r* is not a default phoneme in English (McCarthy 1993: 190). In this connection, it is important to note that McCarthy's proposal was made under the Containment Theory or Parse-Fill Theory (earlier version of OT opposed to the later Correspondent Theory) which does not allow any insertion of new segments but default segments. McCarthy therefore introduces a special rule which he argues is a phonologically arbitrary stipulation that is outside the system of Optimality.

This means that Gen provides *Wandaɹ* as a member of the candidate set. However, H & I rightly point out the problems of this kind of analysis:

> [T]his move is ... unsatisfactory both on conceptual and on empirical grounds. Conceptually, reliance on an arbitrary stipulation that is outside the system of Optimality is equivalent to giving up on the enterprise. Data that cannot be dealt with by OT without recourse to rules are fatal counterexamples to the OT research programme. From an empirical point of view the proposed extension encounters a number of serious problems overlooked by McCarthy. For instance, McCarthy's general *r*-insertion rule (∅→*r*) will extend the Gen sets not only for inputs such as *Wanda* but also for the other cases illustrated in [(10)] (H&I: p. 337-8).

(10) /wanda/ → {wanda, wandaɹ} 'Wanda'
/sij/ → {sij, sijɹ} 'see'
/sijr/ → {sijr, sijrɹ} 'sear'

This means that once we allow Gen to epenthesize *r* after words ending in *ɑ*, *ɔ*, and *ə*, as in McCarthy (1993), we cannot stop *r* from being epenthesized after words ending in the other vowels. H & I (p. 338) demonstrate one of the empirical problems, using the word *seeing*. In the following tableau, Final-C! is a crisp version of Final-C, which is satisfied only by a coda consonant, not by an ambisyllabic consonant. The space between segments indicates a syllable boundary, and the sequences such as *rr* or ɹɹ represent an ambisyllabic segment.

(11)

/sij +ɪŋ/	*Cod/r	Final-C	Ons	NoComplexCoda	Final-C!
☞ a. sij ɹɪŋ					
b. sij jɪŋ					*!
c. sijɹ ɹɪŋ				*!	*
d. sij ɪŋ			*!		
e. sijɹ ɪŋ	*!		*	*	

Candidates (a), (c), and (e) have an epenthetic *r*. The epenthetic *r* in (a) is syllabified as an onset of the second syllable, while the epenthetic *r* in (e) is syllabified as a coda of the first syllable. The *j* in (b) and epenthetic *r* in (c) are ambisyllabic. These ambisyllabic consonants enable candidates (b) and (c) to avoid a violation of Final-C. However, these ambisyllabic consonants violate the crisp constraint Final-C!. Tableau (11) shows that we cannot block intrusive *r*s from appearing after vowels other than *ɑ*, *ɔ*, and *ə*, once we allow for the general *r*-insertion rule (∅ → r) in Gen.

H & I continue to indicate other problems that would be arisen when we analyze *r*-related phenomena under OT, even under the Correspondence Theory (McCarthy and Prince 1995). Those problems are encountered when we try to explain the interaction between schwa insertion and *r*-deletion. As mentioned earlier, these processes are related to the opacity problem. I will follow H&I's criticism in this matter. They argue that an arbitrary constraint *j{rl}. is necessary for schwa insertion.[7] The constraint *j{rl}. and other new constraints are defined below:

(12) a. *j{rl}.: Do not end a syllable with *j* + liquid.
b. Max: Every input segment has a correspondent in the output.
c. Dep: Every output segment has a correspondent in the input.

Consider first schwa insertion before *l*:

(13)

/fijl/	*j{rl}.	*Cod/r	Final-C	Max(C)	Dep(V)
a. fijl	*!				
b. fij				*!	
☞ c. fijəl					*
d. fij lə			*!		*

Candidate (a) remains intact, violating the highest ranked constraint. Candidate (b) has lost the final *l*, violating Max(C). Candidate (c) has an epenthetic schwa before *l*, whereas candidate (d) has one after *l*. The constraint ranking in (13) does the correct work, selecting candidate (c) as the optimal form. This ranking, however, will not do the correct work with *r*s as shown below:

[7] It will be shown in section 4 that the arbitrary constraint *j{rl}. can be replaced by more principled sonority-based constraint MSD (Minimal Sonority Distance Condition).

(14)

/fijr/	*j{rl}.	*Cod/r	Final-C	Max(C)	Dep(V)
a. fijr	*!	*			
☞ b. fij				*	
c. fijər		*!			*
d. fijə			*!	*	*
e. fijrə			*!		*

Candidate (a) remains faithful to the input, but it violates the highest ranked constraint. Candidate (c) avoids a violation of *j{rl}. by inserting a schwa between *j* and *r*, but still violates *Cod/r. Candidate (d) and (e) avoid *j{rl}. and *Cod/r violations, at the cost of Final-C violation. Here the ranked constraints wrongly choose (b) as the optimal candidate. Note that candidate (d) that is a correct form will always be defeated by candidate (b) in any reranking of the above constraints, because the violation marks of (b) is a subset of those of candidate (d).

To sum up, H&I demonstrated how difficult it is to analyze *r*-insertion and *r*-deletion under the OT framework. In the next section, however, I will show that there is an alternative way of analyzing *r*-phenomena, which can easily be incorporated into OT.

4. Analysis of *r* from a Different Perspective

In the previous section, it has been shown that McCarthy's OT analysis of *r*, in which segment *r* is assumed to be wholly deleted and inserted, is unsuccessful. In this section, the nature of so-called *r*-insertion and deletion will be reviewed from a different perspective.

As for *r*-insertion (intrusion), Hwangbo (1998) shows that *r*-insertion is phonetically motivated and thus a natural phenomenon. He shows that *r*, especially postvocalic *r*, can be treated as a glide in *r*-less dialects, and thus *r*-insertion can be treated as a kind of glide insertion, following Walmsley (1977) and Broadbent (1991). Mainly based on Harshman et al.'s (1977) findings, Hwangbo classifies vowels into three types: palatal (i.e., *i*, *ɪ*, *e*), velar (i.e., *u*, *ʊ*, and *o*) and pharyngeal vowels (i.e., *ə*, *ɛ*, *æ*, *ɑ*, and *ɔ*).[8]

[8] In this connection, there are two points to be mentioned. First, schwa was not

According to the factor analysis by Harshman et al., the vowels classified here as pharyngeal have negative values in Factor 2; palatal vowels positive values in Factor 1; and velar vowels negative values in Factor 1 (Harshman et al. 1977: 702; Hwangbo 1998: 303-305). Given the well-known fact that postvocalic *r*s have a pharyngeal constriction (Delattre and Freeman 1968; Lindau 1985), it would be plausible to suppose that they are pharyngeal or pharyngealized glides (Gnanadesikan 1997: 161-162; Blevins 1997: 231).[9] Based on these assumptions, Hwangbo argues that when glides must be inserted to resolve hiatus, palatal vowels attract a palatal glide *j*; velar vowels a velar glide *w*; and pharyngeal vowels a pharyngeal glide *r*.[10] In addition, he shows that the chosen glides have the shortest distance from the attractor vowels in the vowel space. He concludes that glide insertion in English can be considered to be governed by the economy principle, that is, the minimization of the effort.

Next, *r*-loss can be treated as vocalization or weakening of consonantal strength (Lutz 1994). This position (i.e., *r*-loss as vocalization) is also supported by Kenyon and Knott (1953: xix), Sledd (1966), Donegan (1993: 116~119), Olive et al. (1993: 367), McMahon (1994: 80), McMahon et al. (1994: 303-304), and Blevins (1997: 232). Most interesting among these is a proposal introduced by McMahon et al. (but the proposal is not their own but a reviewer's). The proposal, which is based on Delattre and Freeman (1968), can be summarized as follows. As shown in Delattre and Freeman, *r* has two constrictions in vocal tract: one at palate and the other at pharynx. Furthermore, the pharyngeal constriction of *r* is rather similar to that of ə. Thus, if palatal gesture was reduced in magnitude, the remaining pharyngeal gesture would be regarded as a schwa. From this perspective,

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included in Harshman et al.'s research. However, it would be plausible to classify schwa as pharyngeal since schwa is said to have a similar pharyngeal constriction to that of *r* (McMahon et al. 1994: 303). Second, vowels may be classified differently. For example, Wood (1975, 1979) classifies vowels into four categories based on the degree of vocal tract constriction: palatals ([i-ɛ]-like vowels), velars ([u-ʊ]-like vowels), upper pharyngeals ([o-ɔ]-like vowels), and low pharyngeals ([ɑ-a-æ]-like vowels).

[9] Here, 'pharyngeal glide' means that it has a prominent constriction in pharynx, without ruling out the possibility that the glide has a little bit of constriction in palate.

[10] Some can raise a question of why only *r* is inserted after pharyngeal vowels, since there are other pharyngeal consonants such as *ħ* and ʕ. This is because *ħ* and ʕ are not phonemes (or allophones) of English and are excluded by the undominated constraints *ħ and *ʕ.

the *ə* of *fear* [fijə] can be thought to be derived directly from *r*.

Before going further, however, it will be useful to review in some detail the results *r*-vocalization. The spectrograms presented in Delattre and Freeman show that postvocalic *r*s in Eastern New England and the Coastal South are not fully vocalized, but just weakened. This can be justified by using as a criterion the well-known fact that the typical property of *r* is its low F3 and the resultant closeness between F2 and F3. The distance between F2 and F3 in Eastern New England and the Coastal South (about 600-800 cps) is greater than that of typical American *r*s (about 200-400 cps), but smaller than that of British *r*s (about 1300 cps; Delattre and Freeman 1968: 48-49). What this implies here is that post-vocalic *r* in Eastern New England and the Coastal South still has a trace of *r*. Furthermore, Delattre and Freeman claim that the trace of *r* is found even in British English where *r* has been considered to be fully vocalized or deleted. They report that "when the film is projected in reverse, some sort of [pharyngeal French R] is heard —*for*, *fear*, especially, are heard as [Rhɔf, Rəif]. The term 'r-less' often used in connection with those British postvocalic /r/s is perhaps not very objective, therefore." All these observations lead us to conclude that the articulation of *r* is not completely lost in coda position. Thus, it would be plausible to suppose that *r* merges into the preceding vowel in the case of *for* because the resulting vowel still has a trace of *r*. If it cannot merge into the preceding vowel for some reasons, as in *fear*, it would be realized as pharyngeal vowel *ə*.

It has already been shown that *r* has double constrictions: palatal and pharyngeal constrictions. It is intriguing to observe that the English lateral sound may have double constrictions, that is, palatal and velar constrictions (Sproat and Fujimara 1993). The following quotations show that dark *ɫ*, not clear *l*, is likely to be an underlying form of English lateral sound:

> many of us who live in the '*r*-region' of the country use a dark variety of *l* in all positions of words, ... (Bronstein 1960: 125).
>
> ··· there is a notable difference between the two accents in the realization of the liquid /l/, which is in general 'darker' (more velarized) in GenAm than in RP, ... (Wells 1982: 125).
>
> GenAm /l/ tends to be rather dark. Before stressed vowels it is neutral or only slightly velarized; preconsonantally and finally definitely dark (velarized) (Wells 1982: 490).
>
> Canadian /l/ is dark in all positions (Wells 1982: 495).

> In my speech, which I find to be similar to that of many other Americans in the relevant respect, both light and dark /l/ are rather velarized (back tongue body position) (Hayes 1997: 3)

To account for the above observations it would be more convenient to set up dark *ɫ*, rather than clear *l*, as an underlying form (Borowsky and Horvath 1997). This means that underlying lateral sound has palatal and velar constrictions. Then, clear *l* would be derived from dark *ɫ* when necessary, for example, when it comes to onset position. This would be done by deletion or weakening of velar constriction.

The fact that *r* and *l* have a palatal constriction plus an additional constriction plays a crucial role in the following arguments. In this connection, it is interesting to note Boersma's (1998: 180-184) argument that it is more important to realize rarer features than to realize commoner features. In English, as in almost all languages, palatal constriction is commoner than velar and pharyngeal constriction. This means that the palatal place feature will first be lost if *r* and *l* is placed in the weak position where their place features cannot be fully realized, for example, in coda position. This process has been called the weakening of consonantality. On the other hand, when *r* and *l* occur in the strong position, that is, onset position, nonpalatal features will be weakened or lost. This can be called the positional enhancement of consonantality. In this article we will focus mainly on the weakening process.

To incorporate the above observations, I assume the constriction-based model of feature organization, where features such as *palatal*, *velar*, and *pharyngeal* are defined in terms of constriction locations instead of articulator involvement (Clements and Hume 1995). This model provides us a way of unifying the description of consonants and vowels. Crucially, this approach enables us to group *ɑ*, *ɔ*, *ə*, and *r* as a natural class by the feature *pharyngeal*.

5. A New OT Analysis of *r*

In this section I will provide another OT analysis of *r*, based on the observations of the previous section. The main constraints and their ranking used in this article are as follows:

(15) a. MSD: Minimal Sonority Distance Condition (Steriade 1982: 94-95).
b. *Cod/r: No *r* should be wholly within a syllable coda (H & I: 337; McCarthy 1993).[11]
c. Max: Every input segment has a correspondent in the output.
d. Dep: Every output segment has a correspondent in the input.
e. Ident(F): Correspondent segments have identical values for the feature F (McCarthy and Prince 1995).
f. Ons: Every syllable has an onset.
g. Final-C: Every word must end with (part of) a consonant (H & I: 337; McCarthy 1993).
h. *PL/loc: Every occurrence of place feature is penalized. This constraint ranges over *PL/pal, *PL/vel, and *PL/phar, etc.
(PL = place, loc = constriction location, pal = palatal, vel = velar, phar = pharyngeal)

(16) MSD, *Cod/r ≫ Max, Dep(C^{tr}), Ident(voc), Ident(vel, phar) ≫ Ons ≫ Dep(G) ≫ Final-C ≫ Dep(V) ≫ Ident(pal) ≫ *PL/loc[12]
(C^{tr} = True consonant, G = Glide)

Here we need some comments on the above constraints. First of all, MSD (Minimal Sonority Distance Condition) is a general constraint controlling the sonority difference between tautosyllabic segments, based on sonority hierarchy (cf. McCarthy 1991). Sonority hierarchy proposed by Steriade (1982: 94-95) is illustrated below:

(17) a = 10
e, o = 9
i, u = 8
r = 7

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[11] Here *Cod/r is defined in a crisp manner and Final-C in a non-crisp manner, as in section 3, following H&I (cf. Itô and Mester 1994). Ons must be interpreted in a non-crisp manner. See H&I for the criticism of such use of constraints.

[12] In this article, following Itô & Mester (1994: 39), the ranking Ons ≫ CrispEdge (PrWd) ≫ Final-C is assumed for English ambisyllabicity. This ranking forces a word-final or inserted consonant to be ambisyllabic but prohibits a word-initial consonant (including *r*) from being ambisyllabic. The ranking Ons ≫ Dep(G) wrongly predicts glide insertion word-initially, as in *is* [ɪz] → [jɪz]. However, this result is restricted only to the phrase-initial position. This problem will therefore be solved by the constraint CrispEdge(phrase), which must be ranked above Ons.

l	=	6
m, n	=	5
s	=	4
v, z, ð	=	3
f, Θ	=	2
b, d, g	=	1
p, t, k	=	5

This article is concerned with the sonority distance between high vowels and glides on the one hand, and *r* and *l* on the other: it should be greater than 2.[13] It seems reasonable to suppose that the sonority of *j* and *w* is less than *i* and *u* since *j* and *w* are more consonant-like than *i* and *u* respectively (cf. Kirchner 1998: 189, 197). Then, the sequences *j/w* + *r* and *j/w* + *l* are not allowed in the same rhyme because the sonority distance between glide *j* and *w* (<8) on the one hand, and *r* (= 7) and *l* (= 6) on the other, are too short; that is, their distance is less than 2.

Next, consider Dep family. Dep is usually divided into Dep(C) and Dep(V). It is very important to note here, however, that Dep(C) can be further divided into Dep(C^{tr}) and Dep(G), where C^{tr} represents true consonants and G stands for glides. This distinction will play a crucial role in explaining glide insertion including intrusive *r*s (and historical facts of *r*, which will be addressed in Hwangbo (1999)).

Ident(F) serves to regulate vocalization. Ident(voc) allows *r* and *l* to vocalize since these consonants and the resulting vowels are both vocalic. The ranking Ident(vel, phar) ≫ Ident(pal) reflects the Boersma's observation that it is more important to realize rarer features than to realize commoner features. If *r* or *l* comes to a weak position where it cannot preserve its whole place features, Ident(pal) is first violated. Since Ident(voc) prevents *r* and *l* from being consonants, *r* and *l* should be vowels. Ident(phar) allows *r* to optionally merge into pharyngeal vowels *a*, *ɔ*, and *ə*. This is because merging *r* into pharyngeal vowels *a*, *ɔ*, and *ə* does not violate Ident(phar). If *r* cannot merge into the preceding vowels since they are nonpharyngeal (e.g., *i*, *ɪ*, *u*, *ʊ*, etc.), it becomes *ə* which satisfies Ident(phar). It cannot be *a* or *ɔ* because it always appears in an unstressed place.

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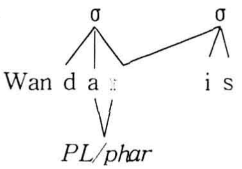
[13] The application domain of MSD may vary depending on where high glides belong within a syllable. If a glide belongs to a nucleus, MSD must apply between a nucleus and a coda. If a glide belongs to a coda, MSD must apply within a coda.

The next constraints to be considered are Ons and Final-C. They are the very constraints to force something to be inserted between vowels and force it to be ambisyllabic. Finally, *PL/loc penalizes every occurrence of place features (constriction location features).[14] Given the fact that every place feature is penalized, spreading existent features, as in (18), are preferred to inserting new features.[15]

(18)



It is assumed that the members of *PL/loc are not ranked to one another. It follows then that they just serve as constraints that demand the minimal use of place features, i.e., the least effort. In the following tableaux, as in section 3, the space between segments indicates a syllable boundary, and the sequences such as *rr* or ːː represent an ambisyllabic segment. For simplicity, only the violation marks for vowels and glides are presented in *PL/loc columns. In other words, PL should be regarded as V-PL (Vowel Place). Irrelevant constraints may be omitted in the following tableaux. Consider now how intrusive *r*s are inserted:[16]

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[14] Hwangbo (1998) proposes two ways in which glide insertion can be explained in OT: by the constraint *Effort (Boersma 1997: 28) which demands the least effort, or by the markedness constraints which penalize every occurrence of place features (Itô & Mester 1994), and thus indirectly reflect the minimization of effort. The latter option is adopted in this article.

[15] A reviewer raises a question about the directionality of spreading because the place feature can be spread from the following vowel. A solution may be to draw on the fact that nuclei are more closely related to codas than to onsets, as reflected in the traditional notion of rhyme. Thus, it is possible to argue that spreading within the same constituent (here, rhyme) is preferable to spreading across constituents.

[16] Intrusive *r* does not take place either in morpheme-internally (e.g., **Aːida* and **Thaːis*) or before level I suffixes (e.g., **voltaːic* and **algebraːic*). According to Wells (1990), the main pronunciations for *Aida* and *Thais* are [aj íːdə] and [θéj ɪs] respectively. Since they are proper names, it seems reasonable to postulate their underlying forms as /aj iːdə/ and /θejɪs/. Then there is no need for *r*-insertion for these words, because *r* is epenthesized only after *ɑ*, *ɔ*, and *ə*. Non-insertion of *r* in *algebraic* might be explained if we assume that the underlying form of *algebra* is *algebr[æ]*, and that the last vowel becomes [ej] to meet a complex constraint or constraints demanding vowel shift in a certain environment, for example, before the suffix *-ic*

(19)

Wanda is	Dep (C^{tr})	Ons	Dep (G)	Final-C	*PL/pal	*PL/vel	*PL/phar
a. Wandat tis	*!				*		**
b. Wanda is		*!		*	*		**
c. Wandaj jis			*		**!		**
d. Wandaw wis			*		*	*!	**
☞ e. Wandar ris			*		*		**

Candidate (a) violates Dep(C^{tr}) because a true consonant *t* is inserted. Candidate (b) violates Ons. These two constraints are ruled out since they violate high ranking constraints. The remaining candidates tie on Dep(G). Here it is to be noted that all candidates have two pharyngeal vowels and one palatal vowel, and are penalized as such by the constraints *PL/loc. Candidates (c) and (d) have an extra place feature, *PL/pal* and *PL/vel* respectively, since they have epenthetic glides. Candidate (e) does not use any additional place feature because it spreads feature *PL/phar* of the preceding vowel to the epenthetic glide, as in (18).[17] As a result, candidate (e) is the optimal form.[18] Note that the optimal form (e) is the one that uses the fewest constriction location features among candidates (c)-(e). That is, it resolves hiatus using the least effort.

The above tableau shows that glides are inserted to satisfy both Ons and Final-C whenever hiatus appears.[19] It also shows that the inserted glides must be assimilated to the preceding vowel to minimize the use of new place features. In general, glides need not be assimilated to the preceding

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(cf. Chomsky and Halle 1968: 185). It follows then that there will be no need to epenthesize any other glide since *j* will become ambisyllabic in the same way as in *seeing* (see (20)). The problem is that it is not easy to formulate the relevant constraints. I will leave this problem for a future research.

[17] Epenthetic *r* might have a slight constriction in palate. However, it can be ignored since it is too weak in comparison with the palatal constriction of *j*. This kind of problem will not arise if we adopt *Effort constraint, as in Hwangbo (1998).

[18] Unlisted candidate *Wand dis*, in which word-final *a* is deleted, is ruled out by Max above Ons.

[19] The ranking Ons ≫ Dep(G) ≫ Final-C does not entail that a glide is first inserted into the onset position and then ambisyllabified into the coda position of the preceding syllable. What matters here is that both constraints must be met, if possible, irrespective of which position is filled first.

vowels, as in *aj*, *aw*, and *ɔj*, because Ident(PL) family dominates *PL/loc family (see (16) above). However, if a glide is inserted to satisfy Ons, Final-C, or both, then Ident(PL) becomes inactive because the epenthetic glide does not have any correspondent in the input against which Ident(PL) must be checked. Only in this special case does *PL/loc become active, forcing the inserted glide to share the existing place (*PL/loc*) feature. Thus, this is an instance of the emergence of the unmarked.

Next, consider the word *seeing* in which glides need not be inserted. This example is very important since H&I (p. 338) used it to show one of the empirical problems in McCarthy's (1993) account. Look at tableau (20), comparing it with tableau (11):

(20)

sij+ɪŋ	Dep(C^{tr})	Ons	Dep(G)	Final-C	*PL/ pal	*PL/ vel	*PL/ phar
a. sij ɪŋ		*!			**		
b. sijː ɪŋ		*!	*		**		*
c. sij ːɪŋ			*!		**		*
d. sijː ːɪŋ			*!		**		*
e. si jɪŋ				*!	**		
☞ f. sij jɪŋ					**		

Candidates (a) and (b) have a violation of Ons. Candidates (c) and (d) incur a Dep(G) violation. In candidate (e), the existing glide is resyllabified into the onset position of the next syllable, violating Final-C. In candidate (f), the glide becomes ambisyllabic. Consequently, candidate (f) does not incur any fatal violation and is selected as the optimal form. In this case, markedness constraints *PL/loc do not play an active role since higher ranking constraints have already selected the optimal form.[20] If the vowel in *see* is a monophthong, as in the West Yorkshire dialect (Broadbent 1991), a glide will have to be inserted. Then, *PL/loc will be active and select *j*.

Tableau (20) shows, unlike (19), that if the preceding word ends in a glide, then the glide becomes ambisyllabic to satisfy Ons. In this case, no

[20] It is assumed that the *i* and *j* of the vowel ij share the palatal feature.

new glides are inserted because the insertion of a glide incurs a gratuitous violation of Dep(G).

In (21), we consider linking *r* exemplified in (1b):

(21)

Homər is	*Cod/r	Max	Dep(C^{tr})	Ons	Dep(G)	Final-C
a. Homət tis		*!	*			
b. Homə is		*!		*		*
c. Homəj jis		*!			*	
d. Homə[illegible] [illegible]is		*!			*	
☞ e. Homər ris						

Here, it is important to note that ambisyllabic consonants do not violate *Cod/r because they are not wholly within a syllable coda (see (15b)). Candidate (b) deletes *r,* violating Max and Ons. Candidates (a), (c), and (d) delete *r* and insert other segments instead, violating Max and Dep. The ambisyllabic *r* in candidate (e) does not incur any violation and makes the candidate optimal.

Now we will consider how *r* is deleted, more precisely, how *r* is vocalized before a consonant:

(22)

Homə$_i$r$_j$ saw	*Cod/r	Max	Id(voc), Id(vel), Id(phar)	Ons	Dep (G)	Fin-C	Dep (V)	Id (pal)
a. Homər saw	*!							
b. Homə$_i$ saw		*!				*		
c. Homə$_i$ ə$_j$ saw				*!		*		
d. Homə$_i$r$_j$ə saw						*	*!	
☞ e. Homə$_{ij}$ saw						*		*

Candidate (a) retains all segments intact but violates *Cod/r. Candidate (b) deletes *r*, violating Max. Candidate (c) vocalizes *r* to satisfy *Cod/r, but at the cost of Ons violation.[21] Candidate (d) adds a schwa at the end to avoid

[21] An unlisted candidate in which *r* merges into ə, resulting in ɜ (long ə), will not

*Cod/r violation. Since the sequence *ər* of candidate (e) merges into *ə*, as argued in the previous section, it does not violate Max.[22] Candidates (d) and (e) tie on Final-C. Candidate (d) further violates Dep(V), making candidate (e) optimal.[23]

Now we will turn to another issue, that is, schwa insertion before *r* and *l*.[24] As indicated before, this may be thought of as causing opacity. In what follows, however, I will show that we can evade the opacity problem if we assume *r*-loss as vocalization. First, look at tableau (23):

(23)

fijr$_i$	MSD	*Cod/r	Max	Ident(voc), Ident(vel), Ident(phar)	Final-C	Dep (V)	Ident (pal)
a. fijr$_i$	*!	*					
b. fijɘr$_i$		*!				*	
c. fij			*!				
d. fijr$_i$$\text{ɘ}$					*	*!	
☞ e. fijə$_i$					*		*

Candidate (a) violates MSD. Candidate (b) violates *Cod/r. Candidate (c) just deletes the final *r* to satisfy MSD, violating Max. Candidate (d)

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succeed since *ɜ* cannot appear in an unstressed position.

[22] The constraint ranking given in this article might select *Hom[ɚ]* as optimal. Consequently, *Cod/r might be replaced by *Rime/rhotic, in which 'rhotic' means something that lowers F3. This constraint would rule out *Hom[ɚ]*.

[23] However, the optimal candidate violates Uniformity ('No Coalescence') that prohibits two or more input segments from sharing an output correspondent (McCarthy and Prince 1995: Appendix A). If we assume that Uniformity is ranked below Dep(V), there will be no problem. Idsardi (p.c.) points out that the above ranking might permit *r* to get split into [rə] without Dep(V) violation in order to avoid *Cod/r violation. In that case, Integrity ('No Breaking;), which is ranked over Uniformity, might eliminate *Home[rə]*.

[24] Schwa epenthesis, like *r*-intrusion, does not occur either stem-medially or before level I suffixes, as in *Healey* *[hijɘlij], *Gaelic* *[gejɘlɪk], *velum* *[vijɘləm], *Byron* *[bajɘrən], and *viral* *[vajɘrəl] (H&I: 333). This is because Final-C, which applies only *word-finally*, does not apply morpheme-internally or at the end of a bound morpheme (*vir-*), and thus the *r* and *l* in question can be syllabified freely onto the next syllable. Then, there is no reason to epenthesize a schwa in these words since MSD is not violated.

escapes MSD violation by adding a schwa at the end, but violating Final-C and Dep(V). Candidate (e) vocalizes *r* into a schwa. Nevertheless, it does not violate Ident(voc) and Ident(phar) since both *ə* and *r* are [+vocalic] and have a pharyngeal constriction, i.e., feature *PL/phar*. It does not incur any Dep violation, but violates Final-C. Here it is important to realize that the *r* cannot merge into a preceding palatal vowel (or diphthong) *ij* since it incurs an Ident(phar) violation. Remember that fear [fijə] has been considered opaque with respect to the schwa insertion rule, because the *r*-deletion rule destroys the environment of schwa insertion (See section 2). Given the fact that there is no schwa insertion and no *r*-deletion, but only *r*-vocalization, [fijə] is no longer an opaque surface form.

We have just considered words ending in *r*. If the final segment is *l*, however, the result will be quite different, as in (24). Here, it is assumed that the epenthetic vowel before *l* is rather *ʊ*-like (slightly higher and backer than neutral vowel). In the following tableaux, *ʊ* represents an *ʊ*-like schwa. For this analysis, it is also assumed that the place feature of the epenthetic *ʊ*-like vowel is spread from the following *l*. This is because *PL/loc demands the minimum use of place features.[25]

(24)

fijl$_i$	MSD	Max	Ident(voc), Ident(vel), Ident(phar)	Final-C	Dep(V)	Ident(pal)
a. fijl$_i$	*!					
b. fij		*!				
c. fijʊ$_i$				*!		*
d. fijl$_i$ʊ				*!	*	
☞ e. fijʊl$_i$					*	

Candidate (a) violates MSD (Minimal Sonority Distance constraint) because the sonority distance between *j* and *l* is less than 2, as mentioned earlier in

[25] In the case of glide insertion (18), the direction of spreading was left-to-right. In this case, however, if epenthetic vowels share the place feature with preceding vowels, it does not make any difference from the previous state. Thus, the feature of the following liquid is spread to the epenthetic vowel. If epenthetic vowels share the place feature with the following *r* or *l*, they may be thought of as the transient states from vowels to *r* or *l*. See fn. 15.

this section. Candidate (b) deletes the final *l* to avoid an MSD violation, but violates Max. In candidate (c), the ʊ-like schwa is a correspondent of the input *l*. Candidate (d) has an epenthetic ʊ-like schwa after *l*, while candidate (e) has an epenthetic ʊ-like schwa before *l*, each violating Dep(V). However, candidate (d) further violates Final-C. The place feature of epenthetic ʊ in candidate (e) is spread from *l*, and thus there is no violation of (unlisted) *PL/loc family. If other vowels are inserted, it will violate one of *PL/loc family.

The above argument help us predict what will happen in dialects where both *r* and *l* are pronounced in coda position. Before *r*, an 'ɑ-like' schwa (symbolized as ə in (23)) which is *PL/phar* would be inserted, while before *l*, a rather 'ʊ-like' schwa which is *PL/vel* would be inserted. This distinction may be disguised, though, because inserted vowels are unstressed and reduced.

If there are dialects where both coda *r* and coda *l* are not allowed, both of them will be vocalized into ə and ʊ respectively. We have already shown the examples of *r*-vocalization. In London speech, we find the examples of *l*-vocalization: *bear* [beə]/ *bell* [beʊ], *fare* [feə]/ *fell* [feʊ], and *tear* [teə]/ *tell* [teʊ] (Gutch 1992: 569; Harris 1994: 206-208). If we add a constraint *Cod/l on the same place with *Cod/r, the constraint ranking proposed here will correctly select the ʊ forms such as (24c), because *l* and ʊ have *PL/vel* in common.[26] In this case, ʊ comes from *l* exactly in the same way that ə comes from *r*. In other words, where *l* comes to a place where its place features cannot fully realized, the commoner palatal feature is lost.[27]

Now consider the words ending in *r*/*l* + vowel initial suffixes. First, consider words ending in *l* + a suffix in McCarthy's (1993) 'less monitored' speech:

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[26] However, in the forms such as *telling*, *l* is not vocalized (Harris 1994: 267) since *l* is syllabified onto the onset of the next syllable, exactly as predicted by the proposed ranking.

[27] The laterality will disappear, too. *l* cannot be *g* or ɣ because of Ident(voc).

(25)

fijl+ɪŋ	MSD	*Cod/r	Max	Ons	Final-C	Dep(V)
a. fijl lɪŋ	*!					
b. fijəl lɪŋ						*
☞ c. fij lɪŋ						

Candidate (a) violates MSD. Candidate (b) inserts a schwa, violating Dep(V). In candidate (c), final *l* is wholly resyllabified into the onset of the next syllable without any violation, because an underlying glide *j* functions as a coda and thus does not incur a Final-C violation. Thus, (c) is the optimal output.

Now we will consider the words ending in *r* + a suffix in 'less monitored' speech:

(26)

fijr+ɪŋ	MSD	*Cod/r	Max	Ons	Final-C	Dep(V)
a. fijr rɪŋ	*!					
b. fijər rɪŋ						*!
☞ c. fij rɪŋ						

In candidate (c), *r* is wholly resyllabified into the onset of the next syllable and thus (c) does not violate any constraint.

Consider the 'more monitored' trisyllabic pronunciations of *filing* [fɑjəlɪŋ] and *fearing* [fijərɪŋ] presented in (6). They need a different explanation. These pronunciations can be treated by output-to-output faithfulness constraints, that is, BA (base-to-affixed form) constraints (Benua 1995, 1998; Hwangbo 1997). The relevant constraint is MAX_{BA} and it will be sufficient for it to be ranked somewhere above Dep(V).

(27)

fijl$_i$+ɪŋ Base: [fijəl]	MSD	*Cod/r	Ons	Max_{BA}	Final-C	Dep (V)
☞ a. fijəl$_i$ l$_i$ɪŋ						*
b. fij lɪŋ				*!		

(28)

fijr$_i$+ɪŋ Base: [fijə]	MSD	*Cod/r	Ons	Max$_{BA}$	Final-C	Dep (V)
☞ a. fij÷r$_i$ r$_i$ɪŋ						*
b. fij rɪŋ				*!		

As illustrated above, candidates (27b) and (28b) violate Max$_{BA}$ because they miss a schwa. Thus, candidates (27a) and (28a) are optimal outputs.[28]

In sum, it has been shown in this section that the so-called *r*-deletion can and must be treated as *r*-vocalization and *r*-insertion as glide insertion, and then, that they can be explained in terms of OT.

6. Concluding Remarks

The OT analysis proposed in section 4 solved many, though not all, problems that H & I raised in their critique of McCarthy's (1993) analysis. First, the arbitrariness of *r*-insertion was removed, since *r*-insertion is proved to be part of general glide insertion which obeys the economy principle. Next, the opacity problem was evaded by treating *r*-loss as vocalization.[29] In doing so *r* and *l* were assumed to have double constrictions. This assumption, together with Boersma's observation that it is more important to preserve uncommon features, played a crucial role in capturing parallel behavior of *r* and *l*.[30] The analysis proposed in this article is not unproblematic. For example, it has some difficulties handling non-occurrence of intrusive *r* before level I suffixes, as in *algebraic* (See fn. 16). This and other problems remain to be solved in the future.

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[28] This analysis predicts that the *r* and *l* in casual speech and *r* and *l* in more monitored speech will be phonetically different because the former are wholly in the onset position while the latter are ambisyllabic. I have only indirect evidence of it. Gimson, in 3. 22 of his *Practical Course of English Pronunciation*, points out that in RP, word-final [ɫ] may become [l] if the following word begins with a vowel or *j*, as in *feel it*, *all over*, and *will you* (But see Hayes 1998).

[29] This kind of account, however, cannot "generalize to the full range of observed opacity," as pointed out by McCarthy (1998: 8).

[30] The proposed analysis of *r* distribution is partly supported by Baković's (1999) most recent study. He analyzes *r*-insertion as diphthongization of *ɑ*, *ɔ*, and *ə*, and *r*-deletion as coalescence of *r* with a preceding vowel.

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ABSTRACT

Vocalization and Intrusion of *r* in English

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Deletion and insertion of *r* in some dialects of English (*Homer̸ left* vs. *Wanda· arrived*) have been dealt with by many researchers (McCarthy 1991, 1993; Halle and Idsardi 1997). As pointed out by Halle and Idsardi, there are two non-trivial difficulties in analyzing *r*-phenomena. One is the arbitrariness of *r*-intrusion; that is, why only *r*s, not others, are inserted after *a*, *ɔ*, and *ə*. The other is the opacity problem resulting from the interaction of schwa insertion and *r*-deletion. If schwa insertion takes place between a high glide and a coda *r*, and the coda *r* is deleted afterwards, the result of applying these rules to the word *fear* /fijr/ will be [fijə]. In this form, the schwa insertion rule becomes opaque since there remains no surface environment for this rule. Such an opacity problem has been considered to be problematic in the standard Optimality Theory (Prince and Smolensky 1993) that is surface-oriented. The primary aim of this article is to provide a unified way of resolving the above two problems. To this end, I adopt an alternative view of *r*-phenomena, in which *r*-deletion is treated as *r*-vocalization (weakening) and *r*-insertion as glide insertion. Based on these assumptions, a new OT analysis is proposed.

151-742
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