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English Vowel Hiatus and Consonant Epenthesis*

Minkyung Lee
(Daegu University)

Lee, Minkyung. "English Vowel Hiatus and Consonant Epenthesis." ***Studies in English Language & Literature*** **44.4 (2018): 89-110.** Vowel hiatus arises when two vowels are locally adjacent but heterosyllabified within words or across word boundaries. In English, as well-described, vowel clash is resolved by two strategies; glide insertion and glottal stop insertion. In fact, these sounds are not underlyingly present but added for ease of articulation in casual or fast speech. Following sonority-driven prominence scale in V_1-V_2 sequences, the least marked glides are the most favored to fix vowel hiatus. Which glide is adopted is closely related to the feature of the first vowel; for a palatal /j/-glide, V_1 is a high front vowel, for a labio-velar /w/-glide, a high back vowel and for a central liquid /r/-glide, also called the intrusive r, a non-high vowel, i.e. homorganic. Furthermore, provided that V_2 gets stressed, a laryngeal plosive also fills an empty onset even though it is the most marked at the point of vowel hiatus. These hiatus resolution strategies are well-couched into Optimality Theory(OT) (Prince and Smolensky, 1993/2004; McCarthy and Prince, 1995) where Dep[F] type constraints ranked over the sonority-driven markedness constraints determine the glide j/w-epenthesis the best and the intrusive r the second-best if the former is banned. Glottal stop addition is also employed as a rescue strategy to remove vowel clash when glides are all blocked, i.e. before V_2 bearing stress. (Daegu University)

Key Words: vowel hiatus, glide insertion, glottal stop insertion, intrusive r, OT

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I. Introduction

Vowel hiatus or vowel clash in English is frequently found when two vowels are right next to each other but they belong to a different syllable as in *hi.a.tus,* i.e. heterosyllabic. According to Casali's (1996) typological research, there is a strong tendency to avoid two vowel sequences within words or across word boundaries. To remove this unwelcome situation, vowels in hiatus readily undergo various phonological changes such as glide formation, vowel elision, or merger, and so on.

In English, when two vowels are juxtaposed heterosyllabically, vowel clash can be resolved by inserting a consonant to break up two vowel sequences; glide insertion sometimes and glottal stop insertion some other times. Here note that a postvocalic r, as a syllabic nucleus, is phonologically regarded as a glide likewise a palatal glide j or a round glide w (Bronstein, 1960; Kahn, 1976; Broadbent, 1991; Uffmann, 2007, among others).[1] For glottal stop insertion, compared to glide insertion, stress placement plays a key role in driving glottal stop epenthesis in English. Note that a glottal stop in English (as well as German) is the only consonant banned intervocalically on the condition that the second vowel is not stress-bearing (Uffmann, 2007:462). In other words, a glottal stop tends to be added before a vowel-initial syllable holding stress as in *hi.á.tus*. However, for glide insertion, when two vowels are locally adjacent, the feature of the first vowel in V_1-V_2 sequences induces its homorganic glide insertion as observed in '*trí.umph'* for glide /j/-insertion and '*you are*' for glide /w/-insertion. Furthermore, vowel hiatus in English can also

[1] There is some disagreement on the transcription of *r*. As argued in Bronstein (1960), some phoneticians preclude *r* with the other glides while others transcribe the *r* as a normal vowel. Kahn (1976:95) argues that English r is quite rare among the world's languages and extremely different from the most common /r/ sounds, i.e. English r is a [-consonantal] glide. Broadbent (1991:294) also claims that *r* is a glide in comtemporary phonology in general. In her feature geometric analysis of feature spreading to an empty onset, intrusive r is treated as Glide Formation, the same process of glide j/w-insertion. Gick (2002) also views that pharyngeal constriction found in *r* is articulatorily quite similar to that of schwa and other low vowels, which implies that *r* and central/back and low vowels are closely connected to each other. F1/F2 of [r] are similar to those of non-high vowels except for the third formant of [r] that is a bit lowered.

be fixed by adding *r*, also called the intrusive r, especially after a schwa vowel as clarified in '*idea of*' in which *r* is intervocalically intruded as a hiatus breaker though there is no *r* in the spelling.

Employing the constraint-based Optimality Theory (henceforth OT) (Prince and Smolensky, 1993/2004; McCarthy and Prince, 1995), this paper examines and analyzes the data of English vowel hiatus. Here two things are highlighted; this paper provides a unified and straightforward analysis on the target data without such analytic chaos found in Uffmann's (2007) OT analysis. Furthermore, glottal stop epenthesis is also used as a rescue strategy (the term from Uffmann, 2007) at the point of vowel hiatus when glides are all blocked in English.

Section 2 examines and discusses the data of English vowel hiatus phenomenon within words or across word boundaries. Here, two different strategies of resolving vowel hiatus will be targeted; a glide, *j*, *w*, or *r*, breaks up two vowel concatenation and a glottal stop also does, especially before a vowel-initial stressed syllable. Section 3 addresses how to resolve English vowel hiatus in a uniformed way. Given sonority-based prominence scale (Prince and Smolensky, 1993) under OT, Dep[F] type constraints determine the best epenthesis to remove vowel hiatus. Glides are favored the most due to their high sonority. However, when glides j/w are blocked, the second-best is a central liquid r, i.e. the intrusive r.[2] In addition, when all glides are banned, i.e. before a vowel-initial stressed syllable, a glottal stop also fills an empty onset due to the demand of a context-sensitive markedness constraint even though it is favored the least at the point of vowel hiatus. Section 4 concludes and summarizes the present paper.

[2] As stated in Bronstein (1960:122), English speakers tend to add *r* due to the use of linking r which is an etymological r, i.e. its existence in spelling. The intrusive r, a normal pattern of the less-educated speakers though, is also widespread among educated and cultured speakers, mainly after /ə/ but less commonly after /ɔ/ and /ɑ/.

II. Vowel Hiatus in English

When vowel hiatus occurs within words or across word boundaries, two vowel sequences may remain unchanged, that is, each vowel is heterosyllabified. However, given Casali's (1996) cross-linguistic research to investigate how natural languages resolve vowel clash, it has been reported that vowel hiatus is strongly disfavored. Accordingly, there are some hiatus resolution strategies adopted such as glide formation, consonant epenthesis, vowel elision, and so forth. Likewise, vowel hiatus in English may be resolved via some mechanisms, which is what comes next.

2.1 Glide Epenthesis

As stated in Bronstein (1960), vowel clash in English is removed by employing glide insertion strategy. In line with Bronstein (1960:111), English has three frictionless glides; *j*, *w*, and *r* that are closely associated with a specific vowel. /j/ begins at or near the [ɪ-i] position, /w/ at or near the [ʊ-u] position, and /r/ at or near [ə~ɜ-] position.

The data laid out in (1) involve the glide j/w-insertion within words or across word boundaries. As observed in (1), the first vowel and the embedded glide are homorganic.[3]

(1) Glide j/w-insertion
  a. A palatal /j/-insertion
    i) Within words
      triumph, hierarchy, fire, seeing, saying, sighing, mosaic, etc.
    ii) Across word boundaries
      clay otters, enjoy it, see Ed, etc.

[3] Throughout the paper, the data adopted here mainly come from Bronstein (1960), Gimson (1980), Carr (1999) and Yavaş (2011) along with McCarthy (1993), Uffmann (2007) and Cruttenden (2014).

b. A labio-velar /w/-insertion
   i) Within words
      fluid, coalition, sowing, doing, following, etc.
   ii) Across word boundaries
      low operas, low and wide, new image, allow it,
      you are, go on, you eat, etc.

From the data laid out in (1), we see that a glide, j or w, is embedded to remove vowel hiatus when two vowels sit side by side.[4] Here notice that a glide that is homorganic to the preceding vowel is added (Ito and Mester, 2009). With a closer look, in (1a), if the first vowel in V_1-V_2 sequences is high and front, or ends in a high-front offglide such as /i, eɪ, aɪ/, a palatal glide /j/ is embedded at the point of vowel hiatus and thus, for instance, 'seeing' is uttered as [si*j*iŋ] and 'see Ed' as [si*j*ɛd]. On the other hand, in (1b), if the first vowel is, this time, high and back, or ends in a high-back offglide such as /u, oʊ, aʊ/, a round glide /w/ is added to break up two vowel sequences. Therefore, 'fluid' is heard as [flu*w*ɪd] and 'slow operas' as [sloʊ*w*ɑp.ɻəz].[5]

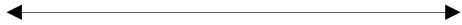
Given the sonority-based prominence scale (Prince and Smolensky, 1993) illustrated in (2), as also adopted in Uffmann (2007), syllable peak is more prominent than syllable margin. This implies that, in syllable peak, the more in sonority, the better but, in syllable margin, it is totally opposite, i.e. the less in sonority, the better.

[4] As argued in Bronstein (1960:124), usage of a glide added to resolve vowel clash is a fault, not commonly found in educated speech. Note that the difference of educated speech from less-educated speech is not our major concern.

[5] Though this paper does not concern the result of the production test made by Davidson and Erker (2014) where the participants are only 14 undergraduate students. It is shown that, within words, glide insertion has no support as a hiatus resolution strategy, especially in American young speakers but, across words, glottal stop insertion is favored under the influence of stress.

(2) Sonority-based segmental prominence

vowels > r > l > nasal > obstruents > laryngeals



peak margin

As Uffmann (2007:461) argues, an intervocalic onset is not treated as margin crosslinguistically but rather as peak. Therefore, the best onset filler is a glide j or w, the second-best a central liquid r and the worst a laryngeal plosive. Here note that the prominence scale in (2) does not tell us where glides j and w belong but it is assumed that 'vowels' is used as a cover term including glides j and w, also called semi-vowels.

Now let us move onto the epenthesis of a central glide r as a hiatus resolution strategy in English. As strongly argued in Bronstein (1960:121), the added r is quite predominant even in the speech of the people who live in the r-less areas of the States, excluding the South. As arranged in (3), even though there is no spelling in a word, i.e. traditionally, non-etymologic r (the term originated from McCarthy, 1993), the added r often emerges after the vowels like /ə, ɔ, ɑ/. Here note again that the added r is also called the intrusive r.

(3) Glide /r/-insertion

a. After the /ə/

ida and May, umbrella over, China office, idea of, Russia and China, drama and music, India and Pakistan, area of agreement, etc.

b. After the /ɔ/ and /ɑ/

drawing, low office, law and order, awe-inspiring, saw a man, saw America, Shah in the story, Utah and Wyoming, etc.

The data in (3) tell us that the first vowel in V_1-V_2 sequences ends in a non-high vowel, intrusive r is readily adopted as a hiatus resolution strategy. In fact, intrusive r between vowels can appear in all contexts where linking r appears, that is, after non-high vowels.

As fully described in Bronstein (1960:121), in some English speaking regions, notably in England and Northeaster part of the States, linking r in postvocalic position is easily dropped off, thus the words of '*fear*' and '*tore*' are uttered as [fiə] and [tɔə], respectively, i.e. the final *r* is not heard or non-rhotic. However, when these words are in such phrases as '*fear of*' and '*tore off*', this r, also called the linking r, is reappeared.[6] Likewise linking r, intrusive r is predominant in the speech of r-less speakers as well, but it is not etymologically-oriented. In fact, r-intrusion is attributed to the analogy with the use of linking r, thus r-addition is overgeneralized to the words where no historical r exists as described in Bronstein (1960:121), Gimson (1980:208) and Uffmann (2007:452).[7]

2.2 Glottal Stop Epenthesis

Given the articulatory phonetic point of view, a glottal stop or a laryngeal plosive is articulated by the compression of lung air and its sudden release at the glottis. It has been well-known that a glottal stop in English is not phonemic and there is no spelled form, either. Also this plosive sound is always voiceless and unaspirated (Gimson, 1980:79). As laid out in (4), a glottal stop is added when the second vowel in V_1-V_2 sequences begins a stressed syllable.[8]

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[6] Gimson (1980:208) states that Received Pronunciation(RP) retains a word-final post-vocalic /r/ as a linking form, especially when the following word begins with a vowel as the following data show; *far off, far away, four aces, answer it, fur inside, near it, wear out, poor Ann*, etc. Here note that an [r] already exists in the spelling. Also note that this paper does not touch upon the difference of linking r from intrusive r in non-rhotic dialects of English such as RP across SE England and in E. Massachusetts. Regarding this, see Wells (1982), Mohanan (1986), Nespor and Vogel (1986) and, for more recent analyses, refer to Harris (1990), Broadbent (1991) and McCarthy (1993).

[7] As argued in Carr (1999:127), intrusive r is socially suppressed in speech but very widespread across many accents of English. Also he claims that there is no reason why it is not spreading to the rhotic accents of English. Likewise, Broadbent (1991:468) supports that intrusive r can occur with the rhotic dialects as well.

[8] A glottal stop, used frequently, is considered an aspect of a less cultivated English, thus it is usually guided avoided (Bronstein, 1960:79). Here note that this paper does not take the sociolinguistic standpoint

(4) Glottal stop insertion
triʔumphant, aʔorta, co-ʔoperate, geʔometry, reʔaction, India ʔoffice

As observed in (4) where V_2 bears stress, as italicized, English speakers tend to add a glottal stop at the point of vowel hiatus. Given Prince and Smolensky's (1993) prominence scale in (2) above, the glottal stop in (4) is the worst epenthetic segment in intervocalic position due to its sonority at the bottom. Note again that a glottal stop is the most unmarked for place, thus the most preferred in syllable margin (de Lacy, 2006; Davidson and Erker, 2014). However, as observed in (4), in intervocalic onset that is crosslinguistically viewed as a peak, a glottal stop also emerges on the condition that the second vowel gets stressed (Bronstein, 1960:79). Therefore, a glottal stop plays a vital role as a transition sound from a final to an initial vowel (Bronstein, 1960:79) as well as a syllable boundary marker (Gimson, 1980:169; Cruttenden, 2014:183).

Taken together, English vowel hiatus is mainly resolved by consonant insertion strategy. Given the sonority-driven prominence scale elaborated in (2) above, three glides are invoked to fill an empty onset. Among them, glide j or w is followed by glide r in preference. However, when all glides are blocked, i.e. before V_2 bearing stress, a glottal stop is adopted to remove vowel hiatus in English.

III. An OT Account to English Vowel Hiatus

As argued in Uffmann (2007), vowel hiatus phenomenon in English, especially intrusive r, has been well-described in English phonology (Sweet, 1908; Jesperson, 1913; Jones, 1917; Kenyon, 1924 for early descriptions while Wells, 1982; Mohanan, 1986; Nespor and Vogel, 1986; Trudgill, 1986; Gutch, 1992; Harris, 1994 for more recent analyses) and also dealt with by various theoretic frameworks from

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regarding the relevant data.

feature geometric analysis (Broadbent, 1991) to constraint-based OT account (McCarthy, 1993; Uffmann, 2007).

Compared to Uffmann (2007), this section provides an OT analysis on the data of English vowel hiatus in a consistent and straightforward way with no analytic chaos found in Uffmann (2007). Glottal stop insertion as well as glide w-insertion in English, not found in Uffmann (2007), is also dealt with in a uniformed way.

3.1 Glide Insertion Strategy

As well-defined in previous literature (Prince and Smolensky, 1993; Uffmann, 2007; Ito and Mester, 2009), vowel hiatus resolution is a response to the requirement of Onset as adopted in (5a).[9] Interestingly enough, in English, Onset is not satisfied via the violation of Max(=No deletion) or Ident(=No change). Rather, Onset is fully met at the expense of Dep as in (5b).

(5) NoHiatus constraints
  a. Onset: Syllables have onsets.
  b. Dep: Avoid segmental insertion.

Given Prince and Smolensky's (1993) sonority-based prominence scale by different prosodic context, i.e. peak vs margin, syllable peak is prominent rather than syllable margin, i.e. onset or coda, thus the former requires more sonorous segment. As argued in Uffmann (2007:461), an intervocalic onset is not treated as margin but as peak, which means that glides j/w are favored the most, a liquid r the next and a laryngeal stop the least as elaborated in (6).

[9] McCarthy (1993) clearly shows how to analyze intrusive r in English under the framework of OT. In his OT analysis, Final-C, instead of Onset, is employed to trigger epenthesis in hiatus situation. Final-C demands a word to be ended in a consonant such as an r or a glide. Though this paper does not delve into the difference of linking r from intrusive r in non-rhotic accents of English, refer to McCarthy (1993) for more details.

(6) Markedness constraints in intervocalic onset (Uffmann, 2007)
*V_V/lar >> *V_V/obs >> *V_V/nas >> *V_V/l >> *V_V/r >> *V_V/V

From the markedness hierarchy in (6), we see that glides are the best as a hiatus breaker and laryngeals the least. A central liquid r, when other glides are all banned, is chosen as the second-best. In line with Uffmann (2007), the markedness constraints adopted in (6) are ranked below Onset and Dep as exemplified in (7).[10]

(7) Glide /j/-insertion

/seeing/	Onset	Dep	*V_V/Lar	*V_V/r	*V_V/V
a. see[ʔ]ing		*	*!		
☞b. see[j]ing		*			*
c. see[r]ing		*		*!	
☜d. see[w]ing		*			*

Here note that the outputs violating Onset, top-ranked, are not considered and that the markedness constraints in (6) are not full-fledged except for those of the segments added as a hiatus breaker. As displayed in (7), to resolve vowel clash, glide /j/ is preferred the most as in (7b). As of now, the constraints and their ranking employed here are exactly the same as those in Uffmann (2007) in which '*key is*' is analyzed in his tableau. However, his analysis is not good enough to filter out the strong competitor in (7d). As will be discussed in detail later, he also should have treated a potential but unattested output with the glide *w* added as in *[key[w]is].

To block the wrong output holding the added [w] glide as shown in (7d), we need a Dep[F] constraint like Dep[Rd] militating against any insertion of the feature [Rd] in the output as posited in (8).

[10] Following Uffmann (2007), the markedness constraint, *V_V/V, is used as a cover constraint including both glides j/w since they are phonetically similar to a high front vowel and a high back vowel, respectively. Also note that Dep is always sacrificed under the demand of Onset, top-ranked, thus its hierarchy may be ranked at the bottom but this paper keeps its hierarchy exactly the same for easy comparison with Uffmann (2007).

(8) Dep[Round](=Dep[Rd]):
No insertion of the feature [round] in the output

Dep[Rd] ranked over Dep successfully picks out the wrong output with the glide [w] inserted as verified in (9).

(9) Revised evaluation (cf. the tableau in (7))

/seeing/	Onset	Dep[Rd]	Dep	*V_V/Lar	*V_V/r	*V_V/V
a. see[ʔ]ing			*	*!		
☞b. see[j]ing			*			*
c. see[r]ing			*		*!	
d. see[w]ing		*!	*			*

The output in (9d) fatally violates Dep[Rd] since it has no correspondent in the input regarding the feature [Rd]. Therefore, the palatal glide j is selected as an onset filler when V_1 is high-front. Between two glides with the same status in prominence scale, a round glide w-insertion is off when the palatal glide j-insertion is switch-on as approved in (9d). Other possible epenthesis such as a central glide r or a glottal stop (or even a coronal t, the second-worst) is readily screened out via the markedness hierarchy given in (6).

For the glide w-insertion, this time, Dep[Fr] is required to bar the glide j-insertion as posited in (10) and its crucial role is witnessed in (11).

(10) Dep[Front](=Dep[Fr]):
No insertion of the feature [front] in the output

As exemplified in (11) below, a glide w is the best choice as a hiatus breaker when the first vowel is high-back, thus the added glide is the homorganic w. Therefore, Dep[Fr] as well as Dep[Rd] plays a key role as a blocker when the added segment is not homorganic to the feature of the first vowel in two vowel concatenation. Note that Dep[F] type constraints are essential since the markedness

constraint, *V_V/V, does not suffice to determine which glide is the best as an onset filler, either a palatal glide j or a labio-velar glide w.

(11) Glide w-insertion

/zoo is/	Onset	Dep[Fr]	Dep	*V_V/Lar	*V_V/r	*V_V/V
a. zoo[ʔ]is			*	*!		
b. zoo[j]is		*!	*			*
c. zoo[r]is			*		*!	
☞d. zoo[w]is			*			*

In the meantime, a central glide r is also invoked to resolve vowel hiatus in English. As argued at length in Uffmann (2007), intrusive r is not arbitrary as a hiatus breaker but as natural as glide j/w-insertion in English. One step further, he answers the question when intrusive r is epenthesized as a hiatus breaker compared to glide j/w-epenthesis. Broadbent (1991) also proposes in her feature geometric analysis that intrusive r can be characterized as glide formation, which makes it possible to provide an explanatory and non-arbitrary analysis.

As also mentioned earlier, intrusive r is adopted as a rescue strategy in English, this time, when the first vowel in V_1-V_2 sequences is non-high. This is the right case where glide j/w-insertion is switch-off for the sake of glide r-insertion as witnessed in (12).

(12) A glide r added after /ə/

/idea of/	Ons	Dep [Rd]	Dep [Fr]	Dep	*V_V/Lar	*V_V/r	*V_V/V
☞a. idea[r]of				*		*	
b. idea[ʔ]of				*	*!		
c. idea[j]of			*!	*			*
d. idea[w]of		*!		*			*

As verified in (12a) in which the first vowel is schwa-final, the r, not present in the spelling, is used as a hiatus breaker in English. Also given the prominence hierarchy in (2) above, intrusive r is the second-best since its sonority is the second-highest. Accordingly, when the glide j/w-insertion is not possible, that is, the first vowel is not high-front nor high-back, the glide r is chosen, instead.

One step further, for the data in which the first word is /ɔ/-final, another Dep[F] constraint is demanded as adopted in (13).

(13) Dep[High](=Dep[Hi]) (Uffmann, 2007):
No insertion of the feature [high] in the output

The role of Dep[Hi] is well-defined in (13) where it is unranked with respect to the other Dep[F] constraints introduced thus far.

(14) A glide r added after /ɔ/

/drawing/	Dep [Rd]	Dep [Fr]	Dep [Hi]	*V_V/Lar	*V_V/r	*V_V/V
☞a. draw[r]ing					*	
b. draw[ʔ]ing				*!		
c. draw[j]ing		*!	*			*
d. draw[w]ing			*!			*

Due to space limit, Onset and Dep are not displayed in the tableau. Under the crucial role of Dep[Hi], the strong competitor in (14d) is fatally ruled out. Otherwise, it wrongly becomes optimal since the glide w is more preferred than the glide r due to their different hierarchy in sonority as clarified in (2). Therefore, as Uffmann (2007) points out, when the glide j/w-insertion is blocked, the central glide r strategy is employed as the second-best as approved in (14a). Note that, for the data where V_1 is /ə/-final, an OT analysis, not displayed here, is fully analogous to the tableau in (14).

In sum, when the first word is vowel-final and the second word is vowel-initial within words or across word boundaries, English adopts consonant insertion strategy to resolve vowel hiatus. In intervocalic onset, glides j/w come first in preference due to their maximal sonority. Glide j-insertion takes place when V_1 is high-front while glide w-insertion occurs when V_1 is high-back. To ban unwelcome outputs to become optimal, Dep[F] type constraints and their role are indispensible since *V_V/V selects both glides j/w equally the best. Dep[Rd] bans a round feature added in the output, Dep[Fr] a front (or [-back]) feature and Dep[Hi] a high feature.[11] In addition, it has also shed light on the intrusive r strategy as glide insertion.[12] When glide j/w-insertion is banned, the central glide r is added, instead since its sonority is the second-highest in prominence scale. In essence, as argued in both Broadbent (1991) and Uffmann (2007), likewise glide j/w-insertion, intrusive r-addition is natural and non-arbitrary process as well.

3.2 Glottal Stop Insertion Strategy

It has been shown that glottal stops are crosslinguistically found to satisfy the onset requirement. Given Lombardi's (1997) universal markedness hierarchy, glottal stops are the least marked while dorsals and labials the most marked and coronals in the middle. Therefore, regarding epenthesis, a glottal stop is favored the most,

[11] Here note that Dep[Hi] in (13) is context-free and thus disfavors insertion of any segment holding the feature [high] in the output. This means that it cannot block any possibility that a high vowel is added in the output. Accordingly, to bar a high front vowel or a high back vowel wrongly added intervocalically, it is assumed that the cover constraint *V_V/V can be demarcated into *V_V/V and *V_V/G and further the former sits over *V_V/Lar even though the current tableaux do not consider this matter. Also see footnote 10.

[12] Broadbent (1991) proposes a novel idea on intrusive r in English (as well as linking r) as a simple case of Glide Formation. Given her feature geometric approach, the appearance of *r* is resulted from the fact that some property of the first vowel spreads into the following empty onset. Therefore, a non-high lax vowel gives rise to r-formation at the point of vowel hiatus in English. For more details, see Broadbent (1991).

especially in syllable margin, notably onset or coda. However, in intervocalic position, a glottal stop hardly appears. Going back to the data in (4), here repeated in (15), a glottal stop is also used as a hiatus breaker in English.

(15) A glottal stop as a hiatus breaker[13]
triʔumphant, aʔorta, co-ʔoperate, geʔometry, reʔaction, India ʔoffice

Given the markedness hierarchy in (6), a glottal stop is the most marked, thus favored the least intervocalically. However, from the data in (15), we see that a glottal stop in English can be added before a vowel-initial syllable that bears stress (Davidson and Erker, 2014). Uffmann (2007:462) strongly argues that English does not allow a glottal stop intervocalically provided that V_2 is not stress-bearing. This implies that a glottal stop, compared to glides, appears when the optimal degree of contrast is maximized according to Uffmann's (2007:458) hypothesis as adopted in (16). Therefore, selecting the best epenthetic consonant is influenced by prominence contrast as well as different context.

(16) Hypothesis on selecting an optimal epenthetic consonant
a. Glottal stops added to maximize the contrast to the following vowel[14]
b. Glides added to minimize the contrast to the following or preceding vowel

[13] Uffmann (2007) does not provide an OT analysis on glottal stop insertion in English, mainly focusing on the comparison of intrusive r-insertion vs glide j-insertion at the point of vowel hiatus. See Uffmann (2007) for the glottal stop insertion found in German in which a glottal stop fills an empty onset as in [ʔɛlç](←/ɛlç/ 'moose').

[14] Regarding the statement in (16a), a glottal stop, though it is favored the most in syllable margin, also occurs intervocalically when V_2 gets stressed. As described in Wells (1982), in English causal speech, a stop sound in coda, especially a coronal /t/, tends to be readily substituted by a glottal stop as uttered in [paʔ](←/pat/) since a laryngeal stop is the least marked for place. However, Bronstein (1960:79) claims that a glottal stop is found even before initially stressed vowels, which leads to maximize the contrast to the following vowel. As also argued in Gimson (1980:169), any initial accented vowel may be reinforced by a glottal stop as witnessed in *It's [ʔ] empty, I haven't seen [ʔ] anybody, She's [ʔ] awfully good*, and so on.

Given the constraints and their ranking introduced so far, glottal stop insertion is unfortunately failed in that glides are preferred the most in the prominence scale. Therefore, on the basis of the hypothesis in (16a), we may venture a context-sensitive markedness constraint to let all glides banned in the onset of the stressed syllable as postulated in (17).

(17) A context-sensitive markedness constraint
*Approximant/$_{\sigma}$[__ ́v (=*APP):
No approximant added before a stressed vowel

Among approximants in English, though a lateral *l* does not occur as a hiatus breaker, the rest including a central r glide plays a role as an onset filler. Given the requirement of *APP presumed in (17) following the hypothesis in (16a), the best way to maximize the contrast to the following stressed vowel is the epenthesis of a glottal stop. Therefore, any possibility that the added consonant is a palatal glide, a labio-velar glide or even a central glide does not exist, especially when V_2 bears stress. The pivotal role of *APP is apparently witnessed in (18).

(18) A glottal stop epenthesized

/triúmphant/	Dep [Rd]	Dep [Fr]	Dep [Hi]	*APP	*V_V/ Lar	*V_V/ r	*V_V/ V
☞a. tri[ʔ]umphant					*		
b. tri[y]umphant				*!			*
c. tri[w]umphant	*!			*			*
d. tri[r]umphant				*!		*	

As exemplified in (18), a laryngeal stop is not favored intervocalically but, as approved in (18a), it is easily added as an onset filler when V_2 gets stressed. In this specific context, all approximants cannot maximize the contrast to the following stressed vowel since they hold high sonority. Therefore, glides are all forbidden as

shown in (18b), (18c) and (18d) due to the demand of *APP crucially ranked over the intervocalic markedness constraints provided in (6). Here note that the optimal output in (18a) only satisfies *APP. In other words, without the crucial role of *APP, (18b) wrongly becomes optimal.

As such, compared to the glide insertion strategy, the glottal stop epenthesis is not common intervocalically in general. However, as evidenced, a glottal stop fills an empty onset of the stressed vowel-initial syllable. To take the glottal stop epenthesis into the unified account and also let the contrast maximized before an onsetless stressed syllable, the context-sensitive markedness constraint *APP, i.e. *glides >> *ʔ, successfully gets rid of glide epenthesis.

3.3 Some Analytic Chaos in Uffmann (2007)

As clarified above, the present OT analysis is basically in the same vein as Uffmann's (2007) OT analysis via the sonority-based prominence scale for the target data of English vowel hiatus. However, as briefly argued earlier, his OT analysis is somewhat defective. Uffmann (2007) mainly focuses on addressing the question why intrusive r, instead of glide j or w, is also embedded when two vowels are in hiatus in English.

The highlight in his OT analysis is two-fold; glides are favored the most to minimize the contrast to the following or preceding vowel in intervocalic onset position. Regarding which glide comes first, the sonority-based markedness constraints in (6) determine the emergence of either glide j/w or r. In addition, intrusive r, due to the fact that its sonority is the second-highest, is also invoked as a rescue strategy when other glide epenthesis is totally interrupted, i.e. after non-high vowels. Therefore, intrusive r-addition is not arbitrary but natural since it is the second-best in its sonority.

Uffmann (2007:466) compares the glide j-insertion (of '*key is*') as in (19) to the intrusive r-insertion (of '*law is*') as in (21). Here let us first consider glide

j-insertion vs glide w-insertion that is not dealt with in his OT analysis as exemplified in (19) and (20).

(19) Glide j-insertion (Uffmann, 2007:466)

/ki: ɪz/	Ons	Dep [Hi]	Dep	*V_V/Lar	*V_V/r	*V_V/V
a. ki:ɪz	*!					
☞b. ki:jɪz			*			*
c. ki:rɪz			*		*!	
d. ki:ʔɪz			*	*!		

Here note that Dep[Hi] is vacuously satisfied and that the optimal output in (19b) best fulfills the intervocalic markedness hierarchy. However, a strong competitor like *[ki:wɪz], not considered in his tableau in (19), wrongly becomes as optimal as (19b). As discussed earlier, *V_V/V cannot remove *[ki:wɪz] when the glide j is added and also vice versa. How about Dep[Hi]? Unfortunately, it cannot, either. Therefore, his analysis is not yet complete.

Though Uffmann (2007) does not deal with the data of glide w-insertion in English, on the analogy of the tableau in (19), let us take a look at the case where the glide w fills an empty onset as in (20).

(20) Glide w-insertion

/zu: ɪz/	Ons	Dep [Hi]	Dep	*V_V/Lar	*V_V/r	*V_V/V
a. zu:ɪz	*!					
☞b. zu:wɪz			*			*
c. zu:rɪz			*		*!	
d. zu:ʔɪz			*	*!		

Here note that, in Uffamnn (2007), glides j/w are treated as a whole group, not separated from one another since they are both high and that the word of [zu:*w*iz]

'the zoo is' is excerpted from Uffmann (2007:463). Though the tableau in (20) looks perfect at first glance, it is not impeccable yet since a strong competitor like *[zu:jɪz] is as optimal as the real output in (20b). In fact, Dep[Hi] fails to ban the emergence of glide j when the glide w is surface-attested. Therefore, regarding the glide j/w-insertion, Dep[Hi] itself is not sufficient in the sense that it cannot tell glide j-insertion from glide w-insertion. In the meantime, Dep[Hi] plays a major role in blocking both glides j/w when glide r-insertion occurs as indicated in (21).

(21) Intrusive-r insertion (a bit simplified) (Uffmann, 2007:466)

/lɔː ɪz/	Ons	Dep [Hi]	Dep	*V_V/Lar	*V_V/r	*V_V/V
a. lɔːɪz	*!					
b. lɔːwɪz		*!	*			*
☞c. lɔːrɪz			*		*	
d. lɔːʔɪz			*	*!		

As clarified in (21b), Dep[Hi] and its crucial role tell us the reason why the glide r is chosen as the rescue strategy when glide w is banned. The competitor in (21b) with a glide w added and further the potential output like *[lɔːjɪz] with a glide j added are all filtered out. However, as apparently shown in (19) and (20), Dep[Hi] is still defective with respect to the difference of glide j-insertion from glide w-insertion.

As such, Uffmann's (2007) OT analysis cannot block the possibility of glide j-insertion when the glide w surfaces and also vice versa. His OT analysis is somewhat limited only to the difference of intrusive r-epenthesis from glide j/w-insertion as a whole, but the difference of glide j-insertion from glide w-insertion is not fully answered yet.

IV. Conclusion

Vowel hiatus has been a long-time concern in English phonology and thus examined and analyzed in various phonological viewpoints. When two vowels are concatenated but heterosyllabified within or across words, the second vowel in V_1-V_2 sequences is onsetless. To get rid of vowel clash, two hiatus resolution strategies are mainly adopted in English; glide insertion and glottal stop insertion. First, glide insertion is two-fold; one is palatal glide j-insertion or labio-velar glide w-insertion and the other is central glide r-insertion.

Based upon prominence-based markedness scale (Prince and Smolensky, 1993), both glide j/w-insertion and glide r-insertion are treated in the same vein in which glide j or w is the best onset filler due to its maximal sonority and glide r is the second-best. Which glide fares better is closely related to the articulatory place of the first vowel; V_1 is high-front, a palatal glide j is added while it is high-back, a labio-velar glide w is intervened. However, when V_1 is non-high, i.e. glide j or w is blocked, a central glide r is chosen, instead. Therefore, an intervocalic onset favors the least contrastive consonants, i.e. glides.

Onset requires consonant epenthesis intervocalically but sonority-based markedness constraints decide which segment is more preferred. However, to bar any unattested outputs to surface, Dep[F] type constraints militate against the addition of a specific feature in the output; Dep[Fr] bans j-insertion when the glide w emerges, Dep[Rd] prohibits w-insertion for the glide j-epenthesis and Dep[Hi] blocks both glides j/w for the sake of central glide r-insertion.

Furthermore, it has been shown that a glottal plosive is also invoked as a rescue strategy when all glides are forbidden. When V_2 gets stressed in V_1-V_2 sequences, a glottal stop fares better to maximize the contrast to the following vowel. To let the stressed vowel more prominent, a context-sensitive markedness constraint *APP is presumed and high-ranked as well. Therefore, all approximants, j/w and r, do not appear before the stressed vowel-initial syllable in English. Here note again that their

high sonority degrades the contrast to the following stressed vowel, i.e. *ʔ* is favored the most.

As such, when two vowels are in hiatus in English, glide j/w-insertion is the best strategy to repair vowel clash but glide r-epenthesis is the second-best when the former is blocked. In addition, a glottal stop is also adopted as an onset filler before the stressed vowel-initial syllable, i.e. glide insertion is switch-off.

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Minkyung Lee (Daegu University/Professor)
Address: Department of English Education, Daegu University
(38453) 201 Daegudae-ro, Gyeongsan-si, Gyeongsangbuk-do
E-mail: milee@daegu.ac.kr

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