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The Relationship between Prosodic and Morphological Constituents in Assimilation Processes of English*

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This study focuses on how prosodically and morphologically based OT constraints are implemented in voicing and place assimilations in English. It is revealed that prosodically based ID-ONS(V)[1]applies to both assimilations except for assimilations occurring with irregular inflection morphemes. Morphologically based meta-constraint ranking, however, plays a role only in progressive voicing assimilation with regular inflection morphemes and regressive place assimilation with complex words. Thus, prosodically and morphologically based constraints are differently implemented in assimilation processes in English. The study shows that general faithfulness constraints should be decomposed into more specified constraints. It is also revealed that the general direction of assimilation is regressive in English and it might be reversed if morphological facts are involved in the process (Lombardi, 2001).

[prosodic and morphological constituents/constraints/ranking/assimilation]

I. INTRODUCTION

Phonological processes are differently implemented in variant positions of prosodic constituents such as syllables, feet, and prosodic words. Thus, syllable onset elements maintain their phonological features while the elements appearing in coda become the

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[1] The special status of syllable onset has been assumed in generative phonology in various cases of phonological processes. But in Optimality Theory (OT), this type of constraint prominently emerges as important, which is specified from general faithfulness constraints.

targets of weakening and neutralization. This is summarized by Beckman (2004) as 'Positional Faithfulness' in which the segments in some linguistic positions are immune to phonological changes whereas those in some other linguistic positions are susceptible to changes. The former is termed 'privileged linguistic positions' and the latter dubbed 'unprivileged linguistic positions.' Some elements of positional faithfulness are presented in (1).

(1) Positional faithfulness (Beckman, 2004)

privileged linguistic positions	unprivileged linguistic positions
root-initial syllable	non-initial syllable
stressed syllable	unstressed syllable
syllable onsets	syllable codas

While positional faithfulness plays a role in phonology, a meta-constraint proposed by McCarthy and Prince (1995): ROOT-FAITH ≫AFFIX-FAITH is also assumed to play a role in phonology as well. The effect of this constraint is observed in progressive voicing assimilation of regular plural and past formation in English. However, in morphologically complex words consisting of a stem+an affix of English, regressive assimilation occurs rather than expected progressive assimilation as evidenced in 'describe-description.' Thus, a morphologically based constraint is overridden by a positional faithfulness constraint such as IDENT-ONSET.

The purpose of this paper is three-fold. First, we provide an in-depth review of assimilation processes in English and propose a comprehensive account of them. Second, we take a close look at how prosodically and morphologically based constraints are implemented in those processes. Third, we discuss the similarities and differences of voicing and place assimilation with respect to the role of different category-based constraints.

This paper is organized as follows. Section 2 presents the data for voicing and place assimilation in English. Section 3 reviews previous analyses of two types of assimilation in English. Section 4 provides a constraint-based analysis of the processes and is followed by conclusion and implications of the paper in Section 5.

II. DATA PRESENTATION

In this section, we present the data for voicing assimilation first, which is divided into three groups: progressive assimilation, regressive assimilation, and no assimilation. The data is mostly adopted from Lombardi (1999), Borowsky (2000), Grijzenhout (2000), Kim

(2004), Kim (2006), and Park (2009). To emphasize voicing assimilation itself, we focus only on the relevant segments which appear in square brackets.

(2) Progressive assimilation

a. cats /t+z/→ [ts], books /k+z/→ [ks], dogs /g+z/→ [gz], cads /d+z/→ [dz]

b. kicked /k+d/→ [kt], lived /v+d/→ [vd], hugged /g+d/→ [gd]

As in (2), the plural and past morphemes in English are /z/ and /d/, respectively and they are affected by the preceding stem final consonants. Thus, the examples in (2) show a case of progressive voicing assimilation where a stem element influences an inflection affix.

The examples in (3) show a case of regressive assimilation where C_2 triggers a change in voice feature of C_1 over a morpheme boundary. In (3), we underlined the segments that are targets of regressive assimilation and the results of assimilation appear in the square brackets.

(3) Regressive voicing assimilation

a. leave-left /v+t/→ [ft], lose-lost /z+t/→ [st], cleave-cleft /v+t/→ [ft]

b. five-fifth /v+θ/→ [fθ], twelve-twelfth /v+θ/→ [fθ], wide-width /d+θ/→ [tθ]

c. describe-description /b+š/→ [pš], conceive-conception /v+š/→[pš]

Unlike the examples in (2), the affixes in (3), which are either derivational or inflectional, cause regressive voicing assimilation by transmitting their voicing feature specifications to the preceding stem final consonants.

On top of such conflicting data with respect to the direction of assimilation, there is yet another type of examples as presented in (4).

(4) No assimilation

a. compounds: basketball [tb], birthday [θd], house dog [sd], dog fight [gf]

b. complex words: hardship [dš], disgrace [sg]

As shown in (4), progressive and regressive assimilation do not occur in compounds and morphologically complex words.

We now introduce the examples for place assimilation, which are also separated into two groups: regressive and progressive assimilation. In the first type, the trigger of assimilation is either a dorsal or labial place feature when it is preceded only by a consonant with a coronal place feature but not vice versa. It should be noted that the 'labial+dorsal' or 'dorsal+labial' place combinations are not affected by place assimilation as seen in (5c) and (5d). The examples are mostly adopted from Lee & Cho (1997), Kwak (1999), and

Cho (2000). In (5), the target and trigger segments are underlined and their realizations are given in the square brackets.

(5) Regressive place assimilation

a. cor+lab→lab: ten minutes [mm], hot manure [pm], in+possible [mp]

b. cor+dor→dor: congress [ŋg], in+conclusive [ŋk], good girl [gg], short cake [kk]

c. lab+dor→no assimilation: cupcake [pk], keep calling[pk]

d. dor+lab→ no assimilation: blackmail [km], magpie [gp]

e. dor+cor→ no assimilation: big dogs [bd], quick talk [kt], cock tail [kt]

f. lab+cor→ no assimilation: same day [md], keep track [pt]

While repressive place assimilation is a very common process in English, progressive place assimilation is observed only in a limited number of words as exhibited in (6). Like the regressive assimilation, the target of assimilation is also confined to the coronal place feature. This process applies to a consonant cluster which is created by the syllabic consonant formation. The syllabic consonants in (6) are indicated by an‘under dot.’ The examples are adopted from Cheun (2004).

(6) Progressive place assimilation

happen [pṃ], seven [vṃ], wagon [gŋ̣], bacon [kŋ̣]

What is interesting in (6) is that place assimilation occurs tautosyllabically, the trigger is an onset segment and the target a coda element, and the coronal place is the only target.

So far we have introduced the examples for voicing and place assimilation in English. In the next section, we will review previous analyses of both assimilation processes and discuss the problems of them.

III. PREVIOUS ANALYSES

In this section, we discuss previous studies on voicing assimilation first. For voicing assimilation, we examine two studies which are based on Optimality Theory (Prince and Smolensky, 1993, 2004; McCarthy and Prince, 1995): Lombardi (1999), and Kim (2004).

Lombardi (1999) argues that the general direction of voicing assimilation in English is regressive and she employs the following constraints in the analysis. The constraints and the ranking of the constraints are given in (7) and (8).

(7) Constraints for voicing assimilation (Lombardi, 1999)

a. AGREE: Obstruent clusters agree in voicing.
b. IDLAR: Consonants should be faithful to underlying laryngeal specification.
c. IDONSLAR: Consonants in the onset should be faithful to underlying laryngeal feature specification.
d. *LAR: Do not have laryngeal features.
e. Harm's Generalization: Voiced obstruents must be closer than voiceless ones to the syllable nucleus.

(8) Constraint ranking for voicing assimilation in English
HARM's GEN ≫ IDONSLAR, IDLAR ≫ *LAR ≫ AGREE

In the analysis, the direction of assimilation in regular affixation is decided by the undominated H's GEN and regressive assimilation is blocked by IDLAR and *LAR. The ranking of IDLAR and *LAR filters out the candidates that undergo regressive assimilation if an input has a voiceless consonant. When an input stem contains a voiced consonant, an output that violates IDLAR is suboptimal since the optimal form is faithful to the input only violating *LAR twice. IDONSLAR is irrelevant while any effect of AGREE is hidden because of the highest ranking H's GEN. The constraint ranking and their role in the selection of an optimal form is shown in Table 1. For the convenience of presentation, we only include the relevant segments in the outputs.

TABLE 1

ca/t+z/	H's GEN	IDONS	IDLAR	*LAR	AGREE
a. [tz]	*!			*	*
☞ b. [ts]			*		
c. [dz]			*	*!*	
ca/d+z/					
☞ a. [dz]				**	
b. [ds]			*!	*	*
c. [tz]	*!		*	*	*

The constraint ranking in Table 1 can also account for the examples for no assimilation whose data was presented in (4). Table 2 illustrates how constraint ranking for progressive voicing assimilation explains the data for no assimilation.

TABLE 2

hou/s+d/og	H's GEN	IDONS	IDLAR	*LAR	AGREE
☞ a. [sd]				*	*
b. [st]		*!	*!		
c. [zd]			*!	**	
har/d+š/ip					

☞ a. [dš]				*	*
b. [dž]		*!	*!	**	
c. [tš]			*!		

In Table 2, the outputs, which are faithful to their inputs, are chosen as optimal and it is secured by IDONSLAR and IDLAR. Candidates that undergo progressive or regressive assimilation violate faithfulness constraints of laryngeal features. Thus, candidate (a) in the first and second evaluation emerges as the most harmonic form.

However, a problem arises if we consider the data for regressive assimilation which was provided in (3). We can witness the incorrect selection of regressive assimilation examples in Table 3, in which we mark the incorrect optimal forms with '☜.'

TABLE 3

lea/v+t/	H's GEN	IDONS	IDLAR	*LAR	AGREE
☜ a. [vt]				*	*
b. [vd]		*!	*!	**	
☞ c. [ft]			*!		
descri/b+š/ion					
☜ a. [bš]				*	*
b. [bž]		*!	*!	**	
☞ c. [pš]			*!		

The output forms that have either IDONSLAR violation or IDLAR violation are eliminated as optimal because the incorrectly chosen candidates satisfy the two constraints. The proposed constraint ranking selects the outputs as optimal that have undergone no assimilation as in lea[vt] and descri[bš]ion. Thus, the constraints and their interaction suggested by Lombardi (1999) do not provide us a complete tool to explain voicing assimilation data of English.

Kim (2004) proposes an analysis based on the constraints employed by Lombardi (1999). Kim modifies AGREE and introduces a new conjunctive constraint based on Smolensky (1995, 1997). We present Kim's (2004) constraints and repeat the constraints that appeared in the analysis of Lombardi (1999).

(9) Constraints for voicing assimilation (Kim, 2000)

a. AGREE: Obstruent clusters in the same constituent (the onset or the coda) should agree in voicing (cf. Steriade, 2001).

b. IDLAR: Consonants should be faithful to underlying laryngeal specification.

c. *LAR: Do not have laryngeal features.

d. *LAR & IDLAR: *LAR and IDLAR are conjoined into a higher ranked constraint.

The modified AGREE ensures that obstruent clusters in the same syllable should have an identical voice feature. *LAR & IDLAR requires that both elements of the conjoined constraint be violated for the constraint to be violated. If only one element of the composite constraint is violated, a candidate does not violate the constraint. This conjoined constraint universally dominates its component constraints such as *LAR and IDLAR. The ranking of constraints in (9) is given in (10).

(10) Kim's constraint ranking for voicing assimilation
*LAR & IDLAR, AGREE ≫ IDLAR ≫ *LAR

Table 4 shows the interaction of constraints in choosing optimal forms of progressive and regressive voicing assimilation in English.

TABLE 4

ca/t+z/	*LAR & IDLAR	AGREE	IDLAR	*LAR
a. [tz]		*!		*
☞ b. [ts]			*	
c. [dz]	*!		*	**
lo/z+t/				
a. [zt]		*!		*
b. [zd]	*!		*	**
☞ c. [st]			*	

The conjoined constraint eliminates ca[dz] and lo[zd] for which regressive and progressive assimilation apply, respectively. Both candidates violate *LAR & IDLAR due to their violation of two subset constraints of the conjoined constraint. On the other hand, the other high ranking AGREE constraint filters out the outputs, which are faithful to their inputs. The two lower ranking constraints are not in play in Table 4. Thus, *LAR & IDLAR and AGREE play a very critical role since they are the major driving force of assimilation and deciding the direction.

The constraint ranking in (10) can account for no assimilation cases in compounds and morphologically complex words as shown in Table 5.

TABLE 5

hou/s+d/og	*LAR & IDLAR	AGREE	IDLAR	*LAR
☞ a. [sd]				*
b. [st]			*!	
c. [zd]	*!		*	**
har/d+š/ip				
☞ a. [dš]				*
b. [dž]	*!		*	**
c. [tš]			*!	

Because assimilation is not involved, the faithful outputs to the inputs are selected as optimal. An output with two voiced obstruents is suboptimal since it incurs a violation of *LAR & IDLAR if the input has a voiceless segment. AGREE does not play any role whereas IDLAR checks identical laryngeal feature mapping between the input and output so any change in the output touches off a violation of this constraint.

The constraint ranking in (10), however, comes short of elucidating the regressive assimilation examples composed of a stem plus an affix with more than one segment in it. This is displayed in the following Table 6.

TABLE 6

descri/b+š/ion	*LAR & IDLAR	AGREE	IDLAR	*LAR
☜ a. [bš]				*
b. [bž]	*!		*	**
☞ c. [pš]			*!	
concei/v+š/ion				
☜ a. [vš]				*
b. [vž]	*!			**
☞ c. [pš]			*!	

Because of the irrelevance of AGREE, which only monitors a consonant cluster in the same syllable, the constraint ranking wrongly predicts the incorrect forms as optimal. In selecting the wrong forms as optimal, the lower ranked IDLAR completes the work. A voiced consonant cluster is eliminated by *LAR & IDLAR which disfavors the occurrence of marked consonants in the output. In sum, the newly introduced conjoined constraint and the modified AGREE cannot explain all the data of voicing assimilation in English.

So far we observed two previous analyses of voicing assimilation in English. Each account provided insights of the process but came short of providing a comprehensive analysis. We will propose an alternative analysis that will be more inclusive than the earlier studies in section 4.

Next, we briefly review an analysis of place assimilation in English. Kwak (1999) proposes an analysis for place assimilation based on Correspondence Theory (McCarthy and Prince, 1995). It is assumed in the analysis that non-coronal consonants in the syllable onset are a cause of place assimilation whereas coronal consonants in the syllable coda are the targets of place assimilation. Based on this, Kwak (1999) employs the following constraints.

(11) Constraints for place assimilation

a. IDENT-F[–CORONAL]: A [–CORONAL] feature in the input should be present in the output.

b. IDENT-F[+CORONAL]: A [+CORONAL] feature in the input should be present in the output.

c. MAX-SEG (ONSET): Underlying onset segments are present in the output.

d. MAX-SEG (CODA): Underlying coda segments are present in the output.

e. NONCOMPLEXITY: Do not have structurally complex places of articulation.

Featural faithfulness constraints (a) and (b) require the identical feature mapping between the input and output. Between these two, ID-F[−COR] should dominate ID-F[+COR] because the trigger of place assimilation in English is non-coronal consonants. Thus, if place assimilation occurs, ID-F[−COR] is satisfied at the cost of violating ID-F[+COR] to share the identical feature. Segmental faithfulness constraints MAX-ONS and MAX-CODA are antagonistic to deletion in that they call for the faithful segmental mapping between the input and output. MAX-ONS is ranked over MAX-CODA because non-coronal onset segments are the triggers of place assimilation while they do not cause the process if they appear in the syllable coda. NONCOMPL bans a consonant sequence with different place feature specification. The constraint ranking proposed by Kwak (1999) is given in (12).

(12) ID-F[−COR] ≫ MAX-ONS ≫ NONCOMPL ≫ ID-F[+COR] ≫ MAX-CODA

The following Table 11 illustrates the examples for place assimilation. We simplified the representation of candidates which originally had a place node of each consonant.

TABLE 7

goo/d+g/irl	ID-F[−COR]	MAX-ONS	NONCOMPL	ID-F[+COR]	MAX-CODA
a. [dg]			*!		
b. [dd]	*!	*			
☞ c. [gg]				*	*
te/n+m/inutes					
a. [nm]			*!		
b. [nn]	*!	*			
☞ c. [mm]				*	*

High ranking ID-F[−COR] eliminates the outputs that fail to maintain their non-coronal input place features so the candidates that undergo coronalization are ruled out. On the other hand, the faithful outputs to inputs are not optimal due to their violation of NONCOMPL by having different place features. Thus, the candidates sharing non-coronal place feature emerge as the best forms.

The following Table 8 shows cases of no assimilation where a syllable onset coronal place does not trigger assimilation when preceded by non-coronal place features.

TABLE 8

coc/k+t/ail	ID-F[−COR]	MAX-ONS	NONCOMPL	ID-F[+COR]	MAX-CODA
☞ a. [kt]			*		
b. [tt]	*!				*
c. [kk]		*!		*	*
kee/p+t/rack					
☞ a. [pt]					
b. [tt]	*!	*	*		
c. [pp]		*!		*	*

In Table 8, high ranking ID-F[−COR] and MAX-ONS play an important role in ruling out the suboptimal forms that undergo either regressive or progressive place assimilation. Even though the optimal forms 'coc[kt]ail' and 'kee[pt]rack' incur a violation of NONCOMPL each, they satisfy ID-F[−COR] and MAX-ONS that the non-optimal forms violate. Thus, the examples of place assimilation can be explained with the five constraints and their interaction.

So far we reviewed Kwak's place assimilation analysis. But if we take a close look at the analysis, we can detect a crucial misapplication of MAX-ONS and MAX-CODA. These segmental faithfulness constraints only refer to the faithful mapping between the input and output segments, and they are not concerned with the featural mapping. The segmental faithfulness constraints are violated when an input consonant does not have its correspondent in the output. Furthermore, it is generally assumed in phonology that syllable structure is not formed in the input. Considering this, MAX-ONS and MAX-CODA are reevaluated in (13), where we are focusing on the second syllable.

(13)	MAX-ONS satisfaction	MAX-ONS trivial satisfaction
Input:	/ bətən/	/bətən/
	||||| ⇨Faithful mapping	||||| ⇨Unfaithful mapping
Output:	[bəʔən]	[bə ən] MAX violation

In the first mapping, MAX-ONS is satisfied even though the onset [ʔ] has its coronal stop correspondent in the input. On the contrary, in the second mapping MAX-ONS is irrelevant and it is satisfied vacuously; MAX is violated instead. If we adopt this general implementation of segmental MAX, the constraint ranking selects an incorrect output as optimal as in the following Table.

TABLE 9

coc/k+t/ail	ID-F[−COR]	MAX-ONS	NONCOMPL	ID-F[+COR]	MAX-CODA
☞ a. [kt]			*!		
b. [tt]	*!				
☜ c. [kk]				*	

Kwak's analysis cannot explain the examples for place assimilation in English comprehensively because the segmental faithfulness constraints are misapplied. Even with some problems in the analysis, the analysis tries to distinguish the asymmetrical status of onset and coda syllable constituents by separating MAX into MAX-ONS and MAX-CODA. In the next section, we will provide a more inclusive analysis of both voicing and place assimilation examples of English.

IV. ANALYSIS

In this section, we present an analysis of voicing assimilation first and then we provide an account for place assimilation. In order to explain the examples for voicing assimilation, we use some constraints employed in previous studies and we also introduce new constraints as well. The constraints we use to account for progressive voicing assimilation are presented in (14).

(14) Constraints for progressive assimilation

a. AGR-TAUTO(V): Obstruent clusters in the same syllable constituent are identical in their voice feature specification.

b. ID-NV(V): Obstruent clusters in nonverbal stems are identical in voice between the input and output.

c. ID-INM(V): Inflection morphemes in the input preserve their voice feature specification of obstruents in the output.

d. IDENT-VER(V): Verbal stems in the input preserve their obstruent voice features in the output.

e. *LAR: Do not have laryngeal features.

AGR-TAUTO(V) triggers assimilation while ID-NV(V) ensures the direction of assimilation. We rank AGR-TAUTO(V) over ID-NV(V) in this analysis. Between non-verbal and verbal stems, non-verbal stems take precedence over verbal stems in maintaining the voice features because verbal stems are affected in the voice by the following affix in derivation as in 'describe~description'. Thus, ID-NV(V) dominates ID-VER(V). ID-INM(V) is dominated by ID-NV(V) but it is equally raked with ID-VER(V). *LAR is ranked lowest but it plays a role in filtering out outputs where inflection morphemes such as {-d} induce regressive assimilation. Based on the constraints and their interaction, we first present how the best forms of regular inflections such as plural and past are selected in Table 10.

TABLE 10

ca/t+z/	AGR-T-σ(V)	ID-NV(V)	ID-INM(V)	ID-VER(V)	*LAR
a. [tz]	*!				*
☞ b. [ts]			*		
c. [dz]		*!			**
hu/g+d/					
☞ a. [gd]					**
b. [gt]	*!		*		*
c. [kt]			*!	*!	

The major source of progressive assimilation in regular affixation is AGR-T-σ(V). Along with this undominated constraint, ID-NV(V) plays an important role in case of plural formation while ID-VER(V) does the same thing for past formation since these two constraints decide the direction of voicing assimilation. It means that the voicing feature of tautosyllable obstruent clusters in nouns and verbs is determined by the voice feature of the final consonant of the stem. The evaluation in Table 10 shows that the meta-constraint ranking proposed by McCarthy and Prince (1995): ROOT-FAITH≫AFFIX-FAITH works for regular grammatical affixation.

The constraint ranking revealed in Table 10 can also explain the irregular past formation examples presented in (3a) which show regressive voicing assimilation. This is presented in Table 11.

TABLE 11

lo/z+t[2]/	AGR-T-σ(V)	ID-NV(V)	ID-INM(V)	ID-VER(V)	*LAR
a. [zt]	*!				*
b. [zd]			*		*!*
☞ c. [st]				*	
lea/v+t/					
a. [vt]	*!				*
b. [vd]			*		*!*
☞ c. [ft]				*	

In Table 11, *LAR also plays a pivotal role in ruling out candidates 'lo[zd]' and 'lea[vd],' though this situation is created by the unranked ID-INM(V) and ID-VER(V). ID-INM(V) and ID-VER(V) fiddle with the candidates either undergoing progressive or regressive assimilation, but it is ultimately decided by the lowest ranked *LAR. As in Table 11, the constraint ranking can select the optimal forms of irregular past tense formation examples which show different direction of assimilation than regular past formation data. In this

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2 We follow previous studies such as Lombardi (1999), Borowsky (2000), Grijzenhout (2000), and Kim(2004) in assuming the past tense morpheme of words such as 'leave' and 'lose' is {-t} rather than {-d}.

irregular pattern of assimilation, McCarthy and Prince's meta-constraint ranking does not seem to work.

Next, we consider the examples that show regressive voicing assimilation. The examples are composed of a stem plus a derivation morpheme whose data was given in (3b) and (3c). In order to explain such data, we introduce 3 new constraints given in (15).

(15) a. ID-ONS(V): Obstruents in the onset and their correspondents in the input are identical in their voice feature specification.
   b. ID-DERM(V): Obstruents in derivational morphemes in the input and output are identical in their voice feature specification.
   c. AGR-H-σ(V): Obstruent clusters over a syllable boundary are identical in their voice feature specification.

ID-ONS(V) and ID-DERM(V) are undominated in the analysis and they do not show a particular ranking. This indicates that obstruents in the onset of a stem and obstruents in derivational morpheme can trigger voicing assimilation. AGR-H-σ(V) ranks lower than AGR-T-σ(V) because obstruents in heterosyllables do not agree in their voice feature in compounds. The following Table shows the evaluation of regressive assimilation in which we do not include irrelevant constraints.

TABLE 12

fi/v+θ/	ID-ONS(V)	AGR-T-σ(V)	ID-DERM(V)	ID-NV(V)	AGR-H-σ(V)	ID-VER(V)	*LAR
a. [vθ]		*!					*
b. [vð]			*!				**
☞ c. [fθ]				*			
descri/b+š/ion							
a. [bš]					*		*!
b. [bž]	*!		*!				**
☞ c. [pš]						*	

In the first evaluation, candidate (c) that undergoes regressive assimilation triggered by a derivational morpheme is selected as optimal. Candidates (a) and (b) are eliminated due to their violation of either AGR-T-σ(V) or ID-DERM(V), respectively. In the second evaluation, ID-ONS(V) plays a crucial role in ruling out (b). Between (a) and (c), (c) undergoes regressive assimilation and edges out the faithful output to input, which violates the lowest ranking *LAR twice. It is observed that stem faithfulness and affix faithfulness are different with respect to voice features, and their ranking runs against the meta-constraint ranking: ROOT-FAITH≫AFFIX-FAITH.

We now discuss the examples that do not undergo any assimilation processes. We include one example from compounds and another from complex words composed of a stem plus a derivational affix with more than one segment in them. This is shown in Table 13, in which we do not include irrelevant constraints for the data.

TABLE 13

hou/s+d/og	ID-ONS(V)	ID-DERM(V)	ID-NV(V)	AGR-H-σ(V)	*LAR
☞ a. [sd]				*	*
b. [st]	*!		*		
c. [zd]			*!		**
di/s+g/race					
☞ a. [sg]				*	*
b. [sk]	*!		*		
c. [zg]		*!			**

The faithful outputs to their input correspondents are selected as optimal by the high ranking ID-ONS(V), ID-DERM(V), and ID-NV(V), which edge out the outputs that undergo either progressive or regressive assimilation such as (b) and (c) in the first and second evaluation.[3]

Now let us consider some exceptional plural formation cases of plural formation in English in which nouns end with /f/ or /ɵ/. When a plural morpheme is added to such words, regressive assimilation produces [vz] and [ðz] instead of expected [fs] and [ɵs]. The exceptional examples are presented in (16). The examples are adopted from Kim (2006).[4]

(16) a. knife[f]-knives[vz], life[f]-lives[vz], thief[f]-thieves[vz]
b. bath[ɵ]-baths[ðz], mouth[ɵ]-mouths[ðz], sheath[ɵ]-sheaths[ðz]

If we apply the constraint ranking used in this section, the incorrect output is selected as optimal instead of the actual optimal form as illustrated in Table 14.

TABLE 14

kni/f+z/	AGR-T-σ(V)	ID-NV(V)	ID-INM(V)	*LAR
a. [fz]	*!			*
☜ b. [fs]			*	
☞ c. [vz]		*!	*	**

[3] A reviewer pointed a possible problem concerning the ranking ID-DERM(V) over ID-NV(V) because the ranking between them implies that derivational morphemes are more important than non-verbal morphemes. So this might be understood as counter intuitive. However, the two constraints employed in this study do not suggest which morphemes are more important but the constraints only imply the difference between derivational and non-verbal morphemes in terms of preserving voice feature in the output.

[4] Readers are referred to Kim (2006) who argues that the meta-ranking is consistently applied to regular affixation while exceptional examples should be treated differently from the regular ones ascribed to the core and periphery components of a language (Chomsky, 1986).

The constraint ranking in Table 14 selects (b) as optimal, however it is the incorrect output. The actual output loses to (b) because it violates ID-NV(V) by changing the voicing feature of the obstruent in the non-verbal stem. Thus, the constraint ranking in this section fails to explain the examples in (16).

But if we assume that the final obstruents of nouns in (16) are /v/ and /ð/, we can account for them with the current constraint ranking. In order to lay some substantial background on the assumption we make for the exceptional examples, we searched the historical traces of the words in (16) and it reveals that most of the words in (16) have voiced obstruent correspondents in their source words as presented in (17). We added more data to (16).

(17) a. Nouns: /f+z/→[vz]

calf<*kalbam(W.Gmc.)	proof<*prueve(O.Fr.)	thief<*theubaz(P.Gmc.)
loaf<*khlaibuz(P.Gmc.)	sheaf<*skaubaz(P.Gmc.)	dwarf<*dweraz(P.Gmc.)
elf<*albiz(P.Gmc.)	wife<*wiban(P.Gmc.)	*? chief<*chief(O.Fr.)*
self<*selbaz(P.Gmc.)	turf<*turb-(P.Gmc.)	*?shelf<*skelf-(P.Gmc.)*
half<*khalbas(P.Gmc.)	life<*liba-(P.Gmc.)	*?wolf<*wulfaz(P.Gmc.)*
leaf<*laubaz(P.Gmc.)	knife<*knibaz(P.Gmc.)	*?gulf<golfe(O.Fr.)*

b. Nouns: /ɵ+z/→[ðz]

bath<*batham(P.Gmc.)	sheath<*skaithiz(P.Gmc.)	wraith<vorðr(O.N.)
mouth<*munthas(P.Gmc.)	cloth<*kalithaz(P.Gmc.)	breath<*bræthaz(P.Gmc.)

As in (17a), most words have historical traces of voiced counterparts in their source words except for the final four.[5] In (17b), nouns with a final [ɵ] have their voiced counterparts historically as well since the letter '-th-' is realized as [ð]. Interestingly, if we consider nouns ending with /f/ which follow the regular plural formation, their source words have the voiceless counterpart of /f/ in the current English words as given in (18).

(18) Nouns: /f+z/→ [fs]

hoof<*khofaz(P.Gmc.)	roof<*khrofaz(P.Gmc.)	grief<grief(O.Fr.)

[5] A problem might arise if we consider the irregular past tense formation. Unlike the historical sources of irregular nouns in (17), those of irregular verbs are not so convincing: lose<los(O.E.), *lausa(P.Gmc.), leave<læfan(O.E.), *laibijan(P.Gmc.), bend<lehnen(Ger.), build<*buthlam(P.Gmc.). In order to explain those irregular verbs in voicing assimilation, the past tense affix for them should be posited {-t} but not {-d}. It might be assumed that the final consonants of those irregular verbs have voiceless consonants based on their origin, but as we can see that such an assumption is not predominantly supported. Thus, the alternative is that the past tense formation morpheme is assumed to be {-t} as it is indicated in footnote 1.

fife<fife, pipe(Ger.)　　safe<en sauf(M.Fr.)　　booth<boþ[6](O.Dan.)

Based on (17) and (18), we assume that the words given in (16) carry historical traces of voice feature, /v/ and /ð/, when the regular inflection is added. If we adopt this assumption, then the constraint ranking can explain the data given in (16).

TABLE 15

kni/v+z/	AGR-T-σ(V)	ID-NV(V)	ID-INM(V)	*LAR
☞ a. [vz]				**
b. [vs]	*!		*	*
c. [fs]		*!	*	
ba/ð+z/				*
☞ a. [ðz]				**
b. [ðs]	*!		*	*
c. [θs]		*!	*	

Thus, the constraint ranking proposed in this study can provide an account of voicing assimilation in English which is more inclusive than the previous analyses. The constraint ranking employed in the analysis is given in (19).

(19) Constraint ranking for voicing assimilation in English
ID-ONS(V), AGR-T-σ(V), ID-DERM(V) ≫ ID-NV(V) ≫ AGR-H-σ(V), ID-VER(V), ID-INM(V) ≫ *LAR

In this analysis, we have seen that the meta-constraint proposed by McCarthy and Prince (1995) is observed by regular plural and past formation examples where the final stem obstruents trigger progressive assimilation. On the contrary, examples of irregular past formation, derivation affixes, and complex words consisting of a stem plus an affix do not follow the meta-constraint. Instead of following ROOT-FAITH≫AFFIX-FAITH, derivation affixes or irregular inflection morphemes trigger regressive assimilation. Furthermore, it is expected that regressive assimilation occurs for a form composed of a prefix plus a stem, and progressive assimilation for a form consisting of a stem plus a suffix if the meta-constraint is observed in complex words. However, obstruents do not change in complex words, which also indicates that the meta-constraint ranking is not observed.

The main factors that emerged in voicing assimilation are that several general constraints should be split into specific constraints in order to provide an analysis to encompass diverse voicing assimilation data in English. AGREE(V) is divided into a tautosyllabic and

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[6] /þ/ is generally used by Germanicists to indicate a phonetic symbol which is equivalent to a voiceless inter-dental fricative /θ/ in IPA.

heterosyllabic constraint to reflect the assimilation difference between within a syllable and over a syllable boundary. Since tautosyllaic obstruent clusters do not violate AGR-T-σ(V) while heterosyllabic obstruent clusters violate AGR-H-σ(V) in compounds and complex words, AGR-T-σ(V) ranks higher than AGR-H-σ(V). This ranking implies that voicing assimilation is obligatory tatutosyllabically while it variably applies heterosyllabically. In terms of meta-constraint ranking, it is well observed by regular affixation in tautosyllable but not by heterosyllable assimilation.

ID-MOR (V) also splits into ID-DERM(V) and ID-INM(V) since derivation morphemes do not change their voicing features in word formation processes whereas inflection morphemes are the general targets of assimilation except for certain irregular inflection morphemes in past and plural formations. Thus, ID-DERM(V) dominates ID-INM(V), which also indicates that affixes are different in the implementation of faithfulness constraints. With respect to the meta-constraint ranking, derivation morphemes override the ranking while inflection morphemes obey the constraint.

The undominated nature of ID-ONS(V) does not distinguish stems from affixes or vice versa, thus it is partially related to the meta-constraint ranking when it refers to the onset position of the stem.

The analysis also reveals the status difference between non-verbal and verbal stems in that even though they behave similarly with regular inflection morphemes, non-verbal stems are immune to voicing change in producing words by affixing derivational morphemes of more than one segment in them.[7] Verbal stems, however, are subject to a change of voicing features when affixed by multi-segmental derivation morphemes.

Next, we provide an analysis of place assimilation in English and discuss differences and similarities between voicing and place assimilation by comparing the behavior of prosodically and morphologically based constraints. To begin with, we present constraints and their interaction to provide an analysis for place assimilation.

(20) Constraints for place assimilation

a. AGR-PL: Adjacent consonants have identical place feature specification.

b. ID-ONS(PL): Consonants in the onset of output have identical place feature with their correspondents in the input.

c. ID-IO(PL): Correspondents in the input and output are identical in place feature.

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[7] Special behavior of mono-segmental derivation morphemes such as {-θ} might be considered stronger than multi-segmental derivation morphemes because the former triggers voicing assimilation while the latter does not cause assimilation when attached to a non-verbal stem: five→fi[fθ] vs 'har[dš]ip.' An alternative view on this might be ascribed to the difference between tautosyllables or heterosyllables.

d. ID-LAB: Input and output correspondents are identical in labial place feature.
e. ID-DOR: Inputs and outputs correspondents are identical in dorsal place feature.
f. ID-COR: Inputs and outputs correspondents are identical in coronal place feature.

AGR-PL requires that adjacent consonants have the same place feature. ID-ONS(PL) specifies that onset segments in output and their input correspondents are identical in their place feature. ID-PL demands that input and output be identical in their place features and this general faithful constraint is dominated by more specified ID-ONS(PL). Among faithfulness constraints, ID-LAB and ID-DOR are ranked higher than ID-COR because dorsal and labial place features trigger place assimilation when preceded by coronal place feature but not vice versa. Thus, ID-LAB and ID-DOR dominate ID-COR. ID-ONS(PL), ID-LAB and ID-DOR are highly ranked in the analysis but they do not show any particular ranking. We rank these three constraints over AGR-PL because adjacent segments do not always satisfy AGR-PL but we rank this constraint higher than ID-PL and ID-COR, which are forced to be violated under the pressure from high ranking constraints.

Place assimilation is triggered by AGR-PL, which does not specify the direction of assimilation. The direction of assimilation is designated by undominated ID-ONS(PL), which is leftward because segments in the onset transmit their place feature to the preceding segments in the coda. Along with this, actual triggers and targets of assimilation are controlled by place features. Onset segments only trigger place assimilation if they are dorsal or labial and if they are preceded by coda segments. The following Table 16 displays the constraint ranking interaction in selecting the most harmonic forms. The following table shows regressive place assimilation.

TABLE 16

i/n+p/ossible	ID-ONS(PL)	ID-DOR	ID-LAB	AGR-PL	ID-PL	ID-COR
a. [np]				*!		
b. [nt]	*!		*!		*	
☞ c. [mp]					*	*
shor/t+k/ake						
a. [tk]				*!		
b. [tt]	*!	*!			*	
☞ c. [kk]					*	*

In Table 16, the faithful outputs to inputs in the first and second evaluation are eliminated by AGR-PL. While the outputs affected by progressive assimilation are also ruled out by undominated ID-ONS(PL) and either ID-DOR or ID-LAB. Thus, the candidates to which regressive place assimilation applies are chosen as optimal. The constraint ranking in Table 16 can be applied to and explain the examples with no assimilation as well. We analyze only 2 out of 4 possible combinations of consonant clusters with no assimilation presented in (5).

TABLE 17

cu/p+k/ake	ID-ONS(PL)	ID-DOR	ID-LAB	AGR-PL	ID-PL	ID-COR
☞ a. [pk]				*		
b. [pp]	*!	*!			*	
c. [kk]			*!		*	
bi/g+d/og						
☞ a. [gd]				*		
b. [gg]	*!				*	*
c. [dd]		*!			*	

As in Table 17, the faithful outputs to inputs emerge as optimal because they edge out the suboptimal forms which incur violations of high ranking ID-ONS(PL), ID-DOR, and ID-LAB. The optimal forms violate AGR-PL, but they are still chosen as optimal since they only violate this constraint, which is not crucial in the analysis.

Next, we apply the constraint ranking to the limited examples of progressive assimilation which were presented in (6). We assume that the data of progressive assimilation undergoes syllabic consonant formation in outputs, for which we do not use constraint that induces this process. Syllabic consonants are indicated by a dot under a consonant ‘ ̣ ’ here.

TABLE 18

ha/pən/	ID-ONS(PL)	ID-DOR	ID-LAB	AGR-PL	ID-PL	ID-COR
a. [pṇ]				*!		
☞ b. [pṃ]					*	*
c. [tṇ]	*!		*!		*	

The most harmonic form in the above table is (b) which only violates the lower ranking constraints, ID-PL and ID-COR while suboptimal forms are eliminated due to their failure to satisfy the higher ranking constraints. Even though the direction of assimilation is different from regressive assimilation, the main causes of progressive assimilation are ID-ONS(PL) and AGR-PL along with specific identity place feature constraints. Thus, one constraint ranking proposed for place assimilation can explain both regressive and progressive place assimilation in English. The established constraint ranking is given in (21).

(21) Constraint ranking for place assimilation of English

ID-ONS(PL), ID-DOR, ID-LAB ≫ AGR-PL ≫ ID-PL, ID-COR

In place assimilation, the meta-constraint, ROOT-FAITH≫AFFIX-FAITH, is only relevant to complex words that are composed of a stem(root) plus an affix. Thus, when a prefix is attached to a stem(root) to derive a new word category and a proper condition for place assimilation is created, place assimilation occurs where the meta-constraint along with AGR-PL can be alternatively applied to account for the process. On the other hand, the meta-constraint is not relevant to place assimilation between independent words. But what sets place assimilation apart from voicing assimilation with respect to the applicability to types of morphemes is that place assimilation applies to derivation morphemes while voicing assimilation only applies to inflection morphemes. Thus, derivation morphemes behave differently in place and voicing assimilation in that they are recipients of feature transmission from stems in place assimilation while they lead a change in the voicing feature of stem obstruents in voicing assimilation. In both assimilation processes, the constraint calling for faithfulness to onset segments plays a critical role in setting the direction of assimilation and it disregards any status difference between stems and affixes. This indicates that a position specific constraint is related to grammatical constituents only when they can project a syllable in them. Without such a prosodic constituent in morphological categories, a position specific constraint cannot play a role and it is satisfied vacuously. In the next section, we summarize the study and its implications to phonology.

V. CONCLUSION

In this study, we have analyzed two types of assimilation in English: voicing and place. We tried to specify the relationship between positional faithfulness and prosodic & grammatical constituents in assimilation processes in English. This is because some phonological processes variably apply to different prosodic and morphological constituents (cf. Chung, 2009). This has been evinced in Optimality Theory by the constraints and their ranking: ID-ONS(F) ≫ ID-IO(F) for prosodic constituents and ROOT-FAITH ≫AFFIX-FAITH for morphological constituents. The position specific ID-ONS(F) constraint generally applies to both voicing and place assimilation except for progressive and regressive voicing assimilation triggered by irregular past morphemes and single-segmental derivation affixes. However, the meta-ranking plays a role in progressive voicing assimilation in which a stem is followed by regular inflection morphemes. It also performs a role in place assimilation in complex words where a prefix is followed by a stem as in 'impossible.' The disparity observed in the role of ID-ONS(F) ≫ ID-IO(F) and ROOT-FAITH ≫AFFIX-FAITH might be ascribed to the intrinsic nature of both prosodic and morphological constituents. In other words, morphological constituents such as affix, root, stem, and word are required to be parsed into a syllable structure in the output so the position based constraint ID-ONS(F) can be conjured up for the outputs *per se* without being limited only to prosodic constituents.

This study has some implications to phonology. First, the study shows that voicing and place assimilation are triggered by the AGREE constraint, which does not specify the direction of the process. Second, it is revealed that the general direction of assimilation is regressive if it is implemented over a syllable boundary (cf. Lombardi 2001). If the process is grounded to the coda position, a morphologically based constraint determines the direction though some irregular morphemes are antagonistic to the constraint. If it involves the onset and coda of a syllable, the segments in the onset should trigger assimilation as in progressive place assimilation. Third, assimilation in English observes the position based ID-ONS(F) ≫ ID-IO(F) more consistently than the morphology based ROOT-FAITH ≫ AFFIX-FAITH. Thus, it may imply that we should consider the status of the meta-constraint ranking by applying it to various phonological and morphological processes before we say the status of such constraint ranking in optimality theory. Fourth, the constraint requiring identical voice is more strictly implemented within a syllable than over a syllable boundary. This may indicate that adjacency of consonants is sensitive to a boundary in phonological implementation. Fifth, voicing and place feature transmission to a neighboring segment is differently realized depending on different prosodic and morphological constituents.

Finally, the result of this study can also be applied to English education with respect to teaching pronunciation of morphologically and grammatically related words. Since the Korean students should deal with the English assimilation data with the two opposite directions, which might cause a problem in learning such morphologically complex words, it might be helpful for the teachers to teach some important constraints for each directional assimilation along with the relevant examples. This might facilitate the learning process of students.

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