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An Optimality Theory Analysis of Velar Softening in English

1. Introduction

Velar Softening, one of the central phonological processes affecting English consonants, has been discussed extensively within several derivational generative models (both linear and non-linear), most notably by Chomsky and Halle (1968) (henceforth SPE), Rubach (1984), Halle and Mohanan (1985), Borowsky (1986) and Halle (2005). The goal of this paper is to analyse the process in question in terms of Optimality Theory (OT), a nonderivational model which rejects the notion of ordered rules in favour of universal output constraints. We also aim to evaluate the extent to which this framework can account for opacity effects involved in Velar Softening.

In section 2 several sets of data which reflect the relevant alternations are presented. We provide both transparent and opaque cases of Velar Softening as well as some exceptions to it. Next we briefly outline the most significant derivational analyses of this process.

In section 3 we present Lee's (2004) account of Velar Softening, according to which this modification can be described in an adequate way within the OT framework which incorporates the multiple-input approach to allomorphy. We argue that this analysis is inaccurate in that it predicts incorrect results for the items in which Velar Softening underapplies or overapplies.

In section 4 we suggest our own account of the relevant alternations, in which we combine Lee’s (2004) multiple-input view and Kang’s (2000) idea of morpho-phonological constraints.

2. Presentation of the data

Velar Softening in English is a phonological phenomenon which affects the velar plosives [k, g]. The voiceless velar plosive [k] and the voiced velar plosive [g] alternate with the voiceless alveolar fricative [s] and the voiced palato-alveolar affricate [ʤ] respectively, as shown in (1).

(1) (a) [k] ~ [s]	(b) [g] ~ [ʤ]
electri[k] ~ electri[s]ity	prodi[g]al ~ prodi[ʤ]y
criti[k]al ~ criti[s]ism	analo[g]ous ~ analo[ʤ]y
medi[k]al ~ medi[s]ine	le[g]al ~ le[ʤ]islate
redu[k]tion ~ redu[s]ent	re[g]al ~ re[ʤ]icide
publi[k] ~ publi[s]ity	lon[g]er ~ lon[ʤ]evity
plasti[k] ~ plasti[s]ine	ri[g]or ~ ri[ʤ]id

According to the derivational approaches, velar plosives undergo Velar Softening when followed by a non-back non-low vowel, i.e. /ɪ/, /iː/ or /e/.

However, there are forms where the context in which this process takes place is less transparent since the [k] ~ [s] and [g] ~ [ʤ] alternations occur word-finally, with no phonetic segment present which could trigger the process. Several examples are listed in (2).

(2) practi[k]al ~ practi[s]e	indu[k]tion ~ indu[s]e
produ[k]t ~ produ[s]e	obli[g]ation ~ obli[ʤ]e

redu[k]tion ~ redu[s]e	alle[g]ation ~ alle[ʤ]e

In addition, there are items which seem even more problematic in that the relevant alternations take place before a front diphthong [aɪ], which starts with an open front vowel (3a), and fail to occur before a non-back non-low vowel (3b). This contradicts the earlier assumption about the context in which Velar Softening operates.

(3) (a)	(b)
publi[k] ~ publi[saɪ]ze	medi[keɪ]t ~ medi[s]ine
criti[k]al ~ criti[saɪ]ze	alle[geɪ]tion ~ alle[ʤ]e
analo[g]ous ~ analo[ʤaɪ]ze	

Finally, in certain forms Velar Softening fails to apply, as in (4), where the velar plosives do not soften, both morpheme-internally (4a) and at morpheme boundary (4b), even though they are followed by a non-back non-low vowel.

(4) (a)	(b)
[k]eep	snea[k]y
[g]et	pin[k]ish
[g]iggle	monar[k]y ~ monar[k]ism

Thus, the examples in (2) and (3a) are cases of rule overapplication, while those in (3b) and (4) are instances of underapplication.

According to SPE, the velar plosives which undergo Velar Softening should be marked as such since this process takes place only in a part of English vocabulary, namely words of Greek and Latin origin. This is necessary so as to account for the failure of Velar Softening in native English words (4). As regards the cases in which velars soften word-finally, the SPE authors claim that /k/ and /g/ in such forms are followed by the underlying vowel /e/, which is deleted after triggering the relevant alternations. The items in which Velar Softening overapplies or underapplies are accounted for by means of postulating abstract underlying vowels, which are appropriately modified by Vowel Shift. Thus, in forms such as *medicate* the velar plosives are followed by an underlying /ǣ/, whereas in words like *publicize* the vowel in question is /ī/. Given this assumption, /k/ and /g/ are turned into [s] and [ʤ] only in the latter case.

The major advantage of the classical generative analysis of Velar Softening is that it accounts for the alternations under discussion using a relatively small number of rules. However, this has been achieved at the cost of a considerable degree of abstractness**,** which manifests itself, for instance, in postulating abstract segments or claims about the synchronic operation of Vowel Shift.

In consequence, the models which appeared in reaction to standard generative framework sought to provide novel, less abstract interpretations of the process under discussion. Thus, according to Borowsky (1986), Velar Softening is a blank-filling rule supplying the [-back] value to the velar plosives, which are underlyingly unspecified with respect to backness. Halle (2005), on the other hand, explores the process in question within the "bottle brush" model and interprets it as an assimilation of velars to the following front vowels. Although these accounts constitute an improvement over the standard generative analysis, they restate some claims made in SPE and, therefore, cannot be regarded as fully satisfactory.

3. Lee's (2004) analysis of Velar Softening

The fundamental assumption underlying Lee's (2004) analysis of Velar Softening is the rejection of a single-UR view on allomorphy, that is the claim that allomorphs are derived from a single underlying representation, as commonly assumed in generative analyses. Lee maintains that some phonological processes, including Velar Softening, cannot be adequately accounted for in terms of OT if the single-UR approach is adopted.[1] Instead, he suggests a multiple-input view on allomorphy, according to which all allomorphs, both stems and affixes, are stored in the lexicon, e.g. *criti{k,s}+al* or *criti{k,s}+ism*.

Lee (2004) claims that the following constraints are responsible for the alternations involved in Velar Softening.[2]

(5) (a) IDENT-IO(F): Output correspondents of an input [γF] segment are also [γF].

(b) *[αback][-αback]: Sequences of segments differing with respect to backness are prohibited.

The constraint IDENT-IO(F) requires that the features of an input segment should be preserved in the output. The constraint *[αback][-αback] militates against sequences of segments differing with respect to backness. According to Lee (p. 75), IDENT-IO(F) outranks *[αback][-αback].

This constraint hierarchy selects the actual surface form for the input *electri{k,s}ity*, as illustrated in Table 1.

Table 1. Evaluation of candidates with the input *electri{k,s}ity* (adapted after Lee 2004:75)

electri{k,s}ity	IDENT-IO(F)	*[αback][-αback]
☛a. electri[s]ity		
b. electri[k]ity		*!
c. electri[t]ity	*![t]	

Candidate (c) is immediately eliminated due to a fatal violation of IDENT-IO(F). In this case the choice of the optimal form depends crucially on *[αback][-αback]. Candidate (b) violates this constraint as

[1] Lee argues that if a single phonological representation is postulated for alternations such as *criti[k]al – criti[s]ism*, OT mechanisms fail to select the optimal form. For details see Lee (2004: 71-74).

[2] According to Lee, yet another constraint should be considered, namely IDENT-STRESS. However, since stress is irrelevant to Velar Softening, this constraint does not play an active part in selecting the actual outputs.

it contains the sequence of [+back] and [-back] segment, i.e. [-kɪ-]. As a result, *electri[s]ity* is selected as the optimal output.

Lee (2004) points out that the identical constraint ranking predicts the surface form for the input *electri{k,s}al*, as evidenced in Table 2.

Table 2. Evaluation of candidates with the input *electri{k,s}ity* (adapted after Lee 2004:76)

electri{k,s}al	IDENT-IO(F)	*[αback][-αback]
☛a. electri[k]al		
b. electri[s]al		*!
c. electri[t]al	*![t]	*

Candidate (c) is ruled out since it fatally violates IDENT-IO(F), whereas candidate (b) is eliminated by *[αback][-αback]. In consequence, *electri[k]al* emerges as the optimal form.

According to Lee (2004), yet another constraint is necessary in order to account for the forms, such as *criti[k]* or *electri[k]*, which surface with the word-final plosive [k] rather than the fricative [s]. The relevant constraint is presented in (6) (p. 76).

(6) Word Final Nonrelease (WFN): Word final consonants should not be released.

WFN militates against word-final released obstruents, that is fricatives and affricates. As Lee observes, since both types of segments can be found word-finally in English, for example in *lea[f]*, *ca[ʃ]* or *mu[ʧ]*, the constraint in question is low in hierarchy, nevertheless, it plays a significant role in selecting forms such as *criti[k]* or *electri[k]*. Table 3 illustrates this claim.

Table 3. Evaluation of candidates with the input *electri{k,s}ity* (adapted after Lee 2004:77)

criti{k,s}	IDENT-IO(F)	*[αback][-αback]	WFN
☛a. criti[k]			
b. criti[s]			*!
c. criti[t]	*![t]		

Candidate (c) incurs a fatal violation of IDENT-IO(F) since it ends in [t] on the surface. The WFN constraint plays a decisive role in selecting the optimal output by ruling out the form with the word-final fricative, that is *criti[s]*. As a result, *criti[k]* becomes the winner.

Lee (2004) concludes that the OT framework which incorporates the multiple-input approach to allomorphy and employs the constraint ranking presented above can provide an adequate account of Velar Softening. In our view, however, the solution advocated by Lee is problematic in several respects and, therefore, it should be rejected. Although the proposal in question produces the correct results for the transparent cases of Velar Softening, that is those in which velar plosives soften before a non-low non-back vowel, it fails to do so for some other forms exhibiting the relevant alternations.

First of all, Lee's solution predicts incorrect outputs for the items in which Velar Softening overapplies, such as *publicize* or *analogize*. This is illustrated in Table 4.

Table 4. Incorrect prediction for *publi{k,s}ize*

publi{k,s}ize	IDENT-IO(F)	*[αback][-αback]
☛a. publi[k]ize		
b. publi[s]ize		*!
c. publi[z]ize	*![z]	

Candidate (c) is ruled out since it violates IDENT-IO(F). The choice between (a) and (b) is decided by the lower-ranked *[αback][-αback]. This constraint eliminates *publi[s]ize*, which contains the sequence of segments differing with respect to backness, i.e. [-saɪ-]. In this way the ranking in Table 4 wrongly selects *publi[k]ize* as the winner.

The same constraint hierarchy also produces incorrect results in the cases in which Velar Softening underapplies, such as *medicate* or *allegation*, as evidenced in Table 5.

Table 5. Incorrect prediction for *medi{k,s}ate*

medi{k,s}ate	IDENT-IO(F)	*[αback][-αback]
a. medi[k]ate		*!
☛b. medi[s]ate		
c. medi[t]ate	*![t]	

The situation in Table 5 is analogous to that in Table 4, where the choice of the optimal output is effected by the lower-ranked *[αback][-αback]. Since candidate (a) contains the sequence of [+back] and [-back] segments, i.e. [-keɪ-], it incurs a fatal violation of the constraint in question. This results in the incorrect selection of *medi[s]ate* as the optimal candidate.

Lee's proposal also fails to account for the items in which Velar Softening takes place word-finally, such as *practi[s]e* or *alle[ʤ]e*. A relevant example is presented in Table 6.

Table 6. Incorrect prediction for *practi{k,s}e*

practi{k,s}e	IDENT-IO(F)	*[αback][-αback]	WFN
☛a. practi[k]e			
b. practi[s]e			*!
c. practi[t]e	*![t]		

Candidate (c) severely violates IDENT-IO(F) and thus it is immediately eliminated. The winner is decided by WFN, which rules out the form containing a word-final released obstruent, that is *practi[s]e*. In this way *practi[k]e* is wrongly selected as the optimal output.[3]

[3] Lee does not specify which segments are affected by *[αback][-αback]. As a result, one may claim that *practi[k]e* violates this constraint as it contains the sequence of [-back] and [+back] segments ([-ɪk]), whereas *practi[s]e* satisfies it (both segments in the word-final [-ɪs] agree in backness). However, given the assumption that *[αback][-αback] and WFN are equally ranked, the result is a tie between (a) and (b).

To sum up, the analysis of Velar Softening put forward by Lee (2004) cannot be accepted as a satisfactory account of the process in question within the framework of OT. In our view, his proposal is inadequate in that it produces the correct results only for the items in which Velar Softening applies in a transparent manner, that is before a non-low non-back vowel. As regards the forms in which this process overapplies or underapplies, the analysis in question predicts wrong outputs. Therefore, the present author is of the opinion that Lee's proposal needs to be modified so as to account for both the transparent and opaque instances of Velar Softening. This issue will be addressed in the next section.

4. An alternative OT analysis of Velar Softening

The account of Velar Softening presented in this section combines two concepts, namely the multiple-input view on allomorphy and Kang's (2000) idea of morpho-phonological constraints. As regards the former, we acknowledge Lee's (2004) suggestion that allomorphs are stored in the lexicon rather than are derived from a single underlying representation. In our opinion, the best results are obtained if the multiple-input approach is combined with morpho-phonological constraints similar to those which Kang uses to account for Palatalization (see Kang 2000:322-331).

The constraints in question reflect the observation that affixes can impose phonological restrictions on the bases to which they are added.[4] Kang (2000:323) supports this claim with numerous examples, one of which is presented in (7).

(7) (a) denẏ/denial	(b) arríve/arrival
betráy/betrayal	propóse/proposal
(c) rebuke/*rebukal	(d) abándon/*abandonal
detach/*detachal	devélop/*developal

[4] Kang points out that affixes can also impose semantic, grammatical and morphological restrictions. In this paper we ignore these three types of conditioning as they are not directly relevant to the discussion.

The forms in (7) clearly show that the nominal suffix -*al* requires the base to meet certain phonological conditions. Thus, a word to which -*al* is attached must end in a vowel (7a) or an anterior consonant (7b) and be stressed on the final syllable (7a-b). The suffix in question is not added to the forms which do not satisfy either the former (7c) or the latter (7d) requirement.

Given the assumption that bases must meet phonological requirements imposed on them by suffixes, Kang (2000) introduces certain morpho-phonological constraints in order to explain the opacity effects involved in Palatalization. In this section we argue that similar constraints can be used to account for Velar Softening. Our analysis of the process in question is based on the observation that the relevant alternations tend to occur before certain suffixes, as illustrated in (8).

(8) physi[k]al ~ physi[s]+ist	prodi[g]al ~ prodi[ʤ]+y
electri[k] ~ electri[s]+ity	re[g]al ~ re[ʤ]+icide
Catholi[k] ~ Catholi[s]+ism	medi[k]al ~ medi[s]+ine
publi[k] ~ publi[s]+ize	redu[k]tion ~ redu[s]+ent

The data presented in (8) demonstrate that the velar plosives /k, g/ soften before the suffixes -*ity, -ist, -ism, -ine, -ize, -y, -ic(ide)* and -*ent*. On the other hand, Velar Softening is blocked when some other morphemes follow /k/ or /g/, as evidenced in (9).

(9) physi[k]+al	analo[g]+ous
medi[k]+ate	alle[g]+ate (+ion)

In (9) the velar plosives fail to soften when followed by -*ate*, -*al* or -*ous*.

Taking into consideration the regularities displayed by the items in (8) and (9), we propose the following morpho-phonological constraints.

(10) (a) ALIGN(I): Align suffix /I/ with the right edge of a base that ends in [+delayed release] consonants. (/I/ = {-ity, -ist, -ism, -ine, -ize, -y, -ic(ide), -ent})

(b) ALIGN(A): Align suffix /A/ with the right edge of a base that ends in [-delayed release] consonants. (/A/ = {-ate, -al, -ous})

ALIGN(I) expresses the generalization that suffixes such as -*ist* or -*ism* attach to the roots which end in [+delayed release] consonants, that is fricatives and affricates. On the other hand, ALIGN(A) states that affixes like -*ate* or -*al* are added to the bases ending in [-delayed release] consonants, that is plosives. Given that both constraints refer to different suffixes, they never conflict and, consequently, cannot be ranked with respect to each other. Since there are English words which violate ALIGN(I) (e.g. *escapism, therapist* or *dramatize*) as well as ALIGN(A) (e.g. *condensate, approval* or *mischievous),* we assume that both constraints are outranked by IDENT-IO(F). There is no need to postulate multiple inputs in words such as *escapism* or *condensate* as the relevant segments do not alternate (*esca[p]e* - *esca[p]ist* - *esca[p]ism, conden[s]e* - *conden[s]ate* - *conden[s]ed*). Under the assumption that IDENT-IO(F) dominates both morpho-phonological constraints, the input segments /p/ (in *esca/p/ism*) and /s/ (in *conden/s/ate*) will be preserved in the output, even when the lower-ranked ALIGN(I) and ALIGN(A) are violated.[5]

Given the ranking established above, it is possible to account for the alternations involved in Velar Softening in a simple and straightforward manner. An example illustrating this claim is presented in Table 7.

Table 7. Evaluation of candidates with the input *electri{k,s}ity*

electri{k,s}ity	IDENT-IO(F)	ALIGN(I)	ALIGN(A)
a. electri[k]ity		*!	
☛b. electri[s]ity			
c. electri[z]ity	*![z]		
d. electri[t]ity	*![t]	*	

[5] Exceptions to Velar Softening such as *monar[k]ism, anar[k]y* or *maso[k]ism* can be handled in the same way. Since the velar plosive /k/ does not alternate in these forms, there is no reason to include any other segment in the input. If IDENT-IO(F) is the top-ranked constraint, the underlying /k/ will always be preserved in the output even if lower-ranked constraints are violated.

The candidates with unfaithful segments (c and d) are eliminated by IDENT-IO(F). Candidate (a) is also ruled out since it incurs a fatal violation of ALIGN(I), which results in the selection of *electri[s]ity* as the actual output.

The same constraint hierarchy produces the correct results for the items such as *electrical*, as demonstrated in Table 8.

Table 8. Evaluation of candidates with the input *electri{k,s}al*

electri{k,s}al	IDENT-IO(F)	ALIGN(I)	ALIGN(A)
☛a. electri[k]al			
b. electri[s]al			*!
c. electri[z]al	*![z]		*
d. electri[t]al	*![t]		

Candidates (c) and (d) severely violate IDENT-IO(F) and thus they are immediately eliminated. The winner is determined by ALIGN(A), which rules out *electri[s]al* and selects *electri[k]al* as the optimal output.

As regards the cases such as *electric* or *public*, it is necessary to employ the WFN constraint in order to obtain the actual surface forms, as shown in Table 9.

Table 9. Evaluation of candidates with the input *electri{k,s}*

electri{k,s}	IDENT-IO(F)	WFN
☛a. electri[k]		
b. electri[s]		*!
c. electri[z]	*![z]	*
d. electri[t]	*![t]	

The constraint ranking in Table 9 eliminates candidates (c) and (d), which violate the top-ranked IDENT-IO(F). Candidate (a), that is *electri[k]*, emerges as optimal since it has a word-final unreleased consonant and, consequently, it satisfies WFN, as opposed to *electri[s]*.

The same constraint ranking predicts the correct surface forms for the items in which Velar Softening either overapplies or underapplies. An example illustrating the former case is presented in Table 10.

Table 10. Evaluation of candidates with the input *publi{k,s}ize*

publi{k,s}ize	IDENT-IO(F)	ALIGN(I)	ALIGN(A)
a. publi[k]ize		*!	
☛b. publi[s]ize			
c. publi[z]ize	*![z]		
d. publi[t]ize	*![t]	*	

Candidates (c) and (d) severely violate IDENT-IO(F). Thus, they are eliminated from the competition. The winner is decided by ALIGN(I) which eliminates *publi[k]ize* and selects *publi[s]ize* as the actual output.

As regards the forms such as *medicate* or *allegation*, in which Velar Softening fails to take place in spite of the appropriate phonetic context, the constraint ranking established thus far produces the desired results.

Table 11. Evaluation of candidates with the input *medi{k,s}ate*

medi{k,s}ate	IDENT-IO(F)	ALIGN(A)	ALIGN(I)
☛a. medi[k]ate			
b. medi[s]ate		*!	
c. medi[z]ate	*![z]	*	
d. medi[t]ate	*![t]		

The candidates with unfaithful segments (c and d) are eliminated by IDENT-IO(F). The choice of the optimal output is effected by ALIGN(A), which selects *medi[k]ate* as the winner.

There is one more group of examples which need to be accounted for, namely the items such as *practice* or *allege*, in which the velar plosives /k, g/ soften word-finally. The constraint hierarchy established in this section fails to select the anticipated outputs in these cases, as illustrated in Table 12.

Table 12. Incorrect prediction for *alle{g,ʤ}e*

alle{g,ʤ}e	IDENT-IO(F)	WFN
☛a. alle[g]e		
b. alle[ʤ]e		*!
c. alle[z]e	*![z]	*

The constraint ranking in Table 12 incorrectly selects *alle[g]e* as the winner. The actual surface form *alle[ʤ]e* is eliminated by WFN, which prohibits word-final fricatives and affricates. This problem could be solved by postulating a constraint disallowing non-released obstruents in the coda position, however, it would produce incorrect results for the items such as *critic* or *electric*, which surface with word-final stops.

The present author is of the opinion that the items in which Velar Softening takes place before a pause constitute an exceptional group of cases. In this paper we acknowledge that the most effective way to handle exceptions and subregularities within the OT framework is to employ the idea of prespecification advocated by Inkelas, Orgun and Zoll (1996). According to them, irregular cases differ from regular ones in that the former have different phonological structures than the latter. Drawing on this notion, we propose that the morphemes undergoing word-final Velar Softening should be represented as follows.

(11) (a) practi/k$_{[+cont][+cor][+ant]}$/

(b) alle/g$_{[+strid][+cor]}$/

In (11) we suggest that the word-final plosives /k, g/ in forms such as *practice* or *allege* are underlyingly followed by a set of floating features which induce the relevant alternations.

In order to obtain the correct outputs in the cases under consideration, it is necessary that the floating features dock to the preceding segments. According to Wolf (1997), this can be achieved when the following constraints are employed.

(12) MAXFLT: All autosegments that are floating in the input have output correspondents.

*FLOAT: No floating autosegments are present in the output.

DEP: The input and the output have the same number of elements.

The constraints presented in (12) work together in order to trigger the docking of the elements which are floating in the input.

Given the assumption that these constraints outrank IDENT-IO(F), the results for the forms like *allege* are as follows.

Table 13. Evaluation of candidates with the input *alle/g* $_{[+strid][+cor]}$ */e*

alle/g $_{[+strid][+cor]}$ /e	MAX FLT	*FLO AT	DEP	IDENT -IO(F)	WFN
a. alle[g $_{[+strid][+cor]}$]e		*!			
b. alle[g]e	*!				
☛c. alle[ʤ]e				*	*
d. alle[gʤ]e			*!		*

In Table 13 *FLOAT eliminates candidate (a), which has floating features in the output. Since input autosegments do not have their output correspondents in candidate (b), it is ruled out by MAXFLT. The choice between the forms (c) and (d) is determined by DEP, which assigns one violation mark to the latter. In this way candidate (c) is selected as the winner.

5. Conclusion

In this paper we have argued that Velar Softening can be described adequately within the OT framework that incorporates the multiple-input approach combined with the morpho-phonological constraints ALIGN(I) and ALIGN(A). The main advantage of such a solution is that it covers a large number of cases, including forms regarded as exceptions in other approaches, by means of a relatively small number of constraints. Furthermore, it is not excessively abstract when compared with earlier analyses as the postulated inputs are closely related to the actual outputs. As regards the cases of word-final Velar Softening, we have assumed that they constitute an exceptional group, which can be handled by prespecification combined with the constraints which induce docking of the elements which are floating in the input.

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