Language, Information and Computation(PACLIC 11), 1996, 479-488

An optimality theoretic account of nasal assimilation in English*

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Abstract

This paper reconsiders nasal assimilation in English within the framework of Optimality Theory and shows that the phenomena can be accounted for in a natural way in terms of some ranked violable constraints. In so doing, I also argue against an account based on structural interpretations of faithfulness, and propose that identity relation between input and output, i.e., *correspondence*, provides the best account. I also present further evidence that as pointed out by Lamontagne and Rice (1995), it is necessary to extend correspondence to the featural level.

1. Introduction

The purpose of this paper is to reconsider nasal assimilation in English within the framework of Optimality Theory (hereafter OT; Prince & Smolensky 1993, McCarthy & Prince 1994). There has been in the literature much discussion on the above phenomena (e.g., Halle & Mohanan 1985, Borowsky 1986 among others). However, none of them provide a satisfactory account. In this paper, I will show that a purely constraint-based approach can account for nasal assimilation in a better way. In so doing, I will argue against an account based on structural interpretations of faithfulness, and propose that identity relation between input and output (i.e., *correspondence*, McCarthy & Prince (1994)) provides the best account. I will also show that as Lamontagne and Rice (1995) assert, correspondence should be extended to the featural level.

The paper proceeds as follows. First, section 2 reviews previous analyses of English nasal assimilation. Second, section 3 presents the general principles of OT and discusses how the constraint-based approach can handle the phenomena under consideration. Finally, section 4 provides a brief summary of the paper.

2. Previous studies

In English, the underlying nasals are /m/ and /n/. Unlike them, [ŋ] does not exist as an independent segment. Rather it is derived from a sequence of nasal and velar obstruent by the so-called Nasal Assimilation. According to Halle and Mohanan (1985), the rule is formulated as (1).

(1) Nasal Assimilation (domain: stratum 2):
/n/ → [ŋ] / __[-son, -cor, -lab]

Sample derivations showing the operation of this rule follow:

(2) /ink/ → /iŋk/ (Nasal Assimilation)
/long/ → /loŋg/ (Nasal Assimilation) → /loŋ/ (/g/-deletion)[1]

As Halle and Mohanan (1985) point out, however, the rule in (1) is blocked when the following syllable is stressed, as exemplified in (3b) in comparison with (3a); i.e., in (3a), /n/ becomes [ŋ], while it remains unchanged in (3b).[2]

(3) a. có[ŋ]gress	b. co[n]gréssional
có[ŋ]cord	co[n]córdance
sý[ŋ]chrony	sy[n]chrónic
í[ŋ]cubate	i[n]clúde
có[ŋ]quer	co[n]cúr
có[ŋ]gruous	co[n]grúity
có[ŋ]crete	co[n]crétion

Without giving a concrete account of the alternations in (3), they simply suggest that the determining factor appears to be the stress contour of the word; i.e., [ŋ] does not occur before stressed vowels in English. However, this is not the case. Observe the examples in (4), where contrary to their assumption, [ŋ] occurs before stressed as well as unstressed vowels.

(4) lí[ŋ]guist	li[ŋ]guístic	Hú[ŋ]gary	Hu[ŋ]gárian
trá[ŋ]quil	tra[ŋ]quílity	Mó[ŋ]gol	Mo[ŋ]gólian
sá[ŋ]guine	sa[ŋ]guínity	larý[ŋ]gophone	láry[ŋ]x
bró[ŋ]chi	bro[ŋ]chítis	ló[ŋ]g	élo[ŋ]gate

Accounting for the phenomena above within the framework of lexical phonology, Borowsky (1986) asserts that the contrast between (3) and (4) are quite systematic. That is, she claims that where Nasal Assimilation applies without reference to stress as in (4), the nasal + velar sequence is in a monomorphemic stem, whereas the stress governed alternations in (3) are always of the form prefix + root. Assuming that the segment /ŋ/ is allowed lexically in English if it shares the place features of the following velar consonant, she asserts that morpheme internally Nasal Assimilation applies as a spreading rule and creates a structure like that in (5a), but across morpheme boundaries it applies as a copying rule and creates the structure in (5b).

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(5) a.    x          x              b.  *   x
          |          |                      |
      [+nasal] [-nasal]                 [+nasal]
              ⋱     |                      |
               [+velar]                 [+velar]
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(6), for example, exemplifies how 'li[ŋ]guist' and 'co[ŋ]gress' are derived from their underlying forms. The monomorphemic form in (6a) has a structure with a single tier, while the bi-morphemic form in (6b) has a structure with two morphemes each occupying a different tier. In the monomorphemic form, Nasal Assimilation applies as a spreading rule and creates a structure like that in (5a). In the bi-morphemic form, in contrast, it applies as a copying rule and creates the structure in (5b). Borowsky says that as a result, the [ŋ] in 'linguist' is derived at level 1 since this will not violate Structure Preservation, while 'congress' and 'congressional' cannot be derived cyclically because the structures resulting from Nasal Assimilation (as a copying process) would violate Structure Preservation.

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(6) a.  x x x  x x x x x        b.  c o n
        | | | ⋱ | | | | |            | | |
        l i n   g u i s t          x x x + x x x x
                                       ⋮   | | | |
                                       g   g r e s
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But her analysis is also untenable in that in order to account for a phonological process, it needs two different rules which apply at different levels. Unlike her assertion, in addition, there are some cases where across morpheme boundaries Nasal Assimilation applies without reference to stress (e.g., 'impossible,' 'compose,' etc.).

3. An alternative analysis

As noted above, in this paper I consider the nasal assimilation by employing the framework of OT, and especially I make use of an identity relation between input and output, i.e., a relation of *correspondence*. Thus I will first provide a brief introduction to OT and the identity relation.

OT espoused by Prince and Smolensky (1993) has the following tenets. First, Universal Grammar provides a set of *Con* of constraints that are universally present in all grammars. Second, constraints are violable; but violation is minimal. Third, an individual grammar consists of a ranking of the constraint set; i.e., the constraints of Con are ranked on a language-particular basis. The notion of minimal violation is defined in terms of this ranking. Fourth, the constraint hierarchy evaluates a set of candidate analyses that are admitted by very general considerations of structure well-formedness. Finally, best-satisfaction of the constraint hierarchy is computed over the whole hierarchy and the whole candidate set; there is no serial derivation. In OT, the grammar is schematically represented as in (7).

(7) a. $\mathrm{Gen}(\mathrm{In}_k) \rightarrow \{\mathrm{Out}_1, \mathrm{Out}_2, ...\}$
  b. $\mathrm{Eval}(\mathrm{Out}_i,\ 1 \leq i \geq \infty) \rightarrow \mathrm{Out}_{real}$

The function Gen generates for any given input a large set of candidate analyses by freely exercising the basic structural resources of the representational theory. Then Eval evaluates the members of the candidate set in terms of their *relative harmony*, or degree of success with respect to the language's ranking of the constraints. It imposes an order on the various candidates, and a maximally harmonic candidate is optimal.

Turning now to the notion *correspondence*, it was first introduced in OT as a base-reduplicant relation in McCarthy & Prince (1994b), and then it was extended to the input-output domain and other linguistic relationships besides (McCarthy & Prince 1994b, 1995). Correspondence is a relation between two structures, such as base and reduplicant or input and output. According to McCarthy and Prince (1994b), correspondence is formally defined as follows:

(8) Correspondence
  Given two strings S_1 and S_2, related to one another as reduplicant/base, output/input, etc., *correspondence* is a function *f* from any subset of elements of S_2 to S_1. Any element α of S_1 and any element β of S_2 are correspondents of one another if α is the image of β under correspondence; that is, $\alpha = f(\beta)$.

In a correspondence-sensitive grammar, the function of Gen is to supply correspondence relations between S_1 and all possible structures over some alphabet. Each candidate pair (S_1, S_2) comes from Gen equipped with a correspondence relation between S_1 and S_2 that expresses the relation between the elements of S_1 and those of S_2. The correspondence relation between input and output is illustrated in (9). Here, subscripted indices are used to indicate the correspondence relationship. In (9a), for example, the /p/ of the input corresponds to the [p] of the output; the /u/ of the input corresponds to the [u] of the output, and so on.

(9) Input = /$p_1a_2u_3k_4t_5a_6$/
  a. $p_1a_2u_3k_4t_5a_6$ b. $p_1a_2ʔu_3k_4t_5a_6$ c. $p_1\ u_3k_4t_5a_6$

As shown above, the elements of the input can stand in correspondence relations with the elements of the various candidates. In (9a), for example, the relation between the input and the output is one-to-one. But the output may also contain more or fewer elements than the input as in (9b) and (9c); that is, [ʔ] is inserted in (9b), while /a_2/ is deleted in (9c). Once the candidates are generated, Eval rates them in terms of their relative harmony with respect to the language-particular constraint hierarchy and determines what is optimal. The optimal candidate is the one that best satisfies the constraint hierarchy.

Given this much theoretical background, in what follows, I will consider how English nasal assimilation can be handled in terms of correspondence. To begin with, for the cases in (3) and (4), the constraints in (10) come into play in selecting optimal outputs.

(10) a. *[...n{k, g}...]$_{\text{foot/monomorpheme}}$ b. SPREAD: Do not spread features.

Constraint (10a) bans the sequence of /n/ and /k/ or /g/ within the foot/monomorpheme, while constraint (10b) is against spreading of features. The tableaux in (11), for example, show that if (10a) ≫ (10b), we predict the correct surface form. In these and other tableaux, constraints are ordered left to right in order of priority, and violation-marks are indicated by *. The optimal candidate is called out by ☞, and fatal constraint violations are signalled by !. Below these fatal violations, cells are shaded to indicate their irrelevance to determining the outcome of the comparison at hand. In addition, ( ) represents foot boundaries.[3] In (11a), candidate (a) violates a highly ranked constraint *[...n{k, g}...]$_{\text{foot/monomorpheme}}$ because of the sequence of /n/ and /g/ that belong to the same foot. This violation is fatal, since the competing candidate satisfies it; therefore, candidate (b) is selected as optimal in spite of its violation of constraint SPREAD. In (11b), candidate (a) meets constraint *[...n{k, g}...]$_{\text{foot/monomorpheme}}$ because /n/ and /g/ are neither tautomorphemic nor within the same foot. Candidate (b) also satisfies it. Thus the decision between them must be passed on to the subordinate constraint SPREAD. Candidate (a) passes but candidate (b) fails it; therefore, the former emerges as optimal. In (11c), candidate (a) contains tautomorphemic /n/ and /g/, violating constraint *[...n{k, g}...]$_{\text{foot/monomorpheme}}$, which is fatal. Although the alternative analysis (b) fails constraint SPREAD, it is selected as optimal. The same reasoning holds for (11d).

(11) a.

	*[...n{k, g}...]$_{f/m}$	SPREAD
a. (cóngress)	*!	
☞ b. (cóŋgress) V [+velar]		*

b.

	*[...n{k, g}...]$_{f/m}$	SPREAD
☞ a. (con)(gréssional)		
b. (coŋ)(gréssional) \ / [+velar]		*!

c.

	$*[...n\{k, g\}...]_{f/m}$	SPREAD
a. línguist	*!	
☞ b. líŋguist V [+velar]		*

d.

	$*[...n\{k, g\}...]_{f/m}$	SPREAD
a. linguístic	*!	
☞ b. liŋguístic V [+velar]		*

Now, observe the following examples. It has been traditionally assumed that in (12), /n/ is first changed into /ŋ/, and then /g/ is deleted.

(12) angma, long, bring, gingham

Under the analysis argued for in this paper, this can be accounted for by invoking the constraint PARSE. In McCarthy and Prince (1994b), PARSE[4] is redefined as a constraint on correspondence as in (13).

(13) PARSE: Every element of S_2 in (S_1, S_2) has a correspondent in S_1.[5]
(where S_2 = input, S_1 = output).

As stated in (13), correspondence operates on the domain of the segment. But this is not enough to account for the data in (12) -- I will return to this below. Rather I argue after Lamontagne and Rice (1995) that correspondence should be extended to the featural level. Accounting for coalescence in Athapaskan languages, that is, Lamontagne and Rice show that in addition to the segmental input/output correspondence, features may stand in a correspondence relation. In other words, whether or not a segment of the input corresponds with a segment of the output depends on whether some features of these segments correspond; i.e., a Root node of the input and that of the output will stand in a correspondence relation if features that they dominate correspond. According to them, therefore, (13) can be restated as in (14).

(14) For two Root nodes X and Y, where X is part of the input and Y the output, X and Y correspond if some features of X correspond with features of Y.

Consider, for example, the relation between the input and the output in coalescence structures like (15). Given the assumption above, the Root node of

Y in the output of (15) has a double correspondence, and hence it corresponds with both X and Y of the input, as indicated through the use of the indices from each of the input segments.

(15)
input	output
/X_1 Y_2/	[$Y_{1,2}$]
| |	/ \
F_1 F_2	F_1 F_2

However, there is a cost to representations like that in (15); i.e., features of the input cannot be randomly distributed in the output. That is, *MC in (16) prevents Gen from randomly distributing features of the input in the output.

(16) *Multiple Correspondence (*MC): Elements of the input and the output must stand in a one-to-one correspondence relationship with each other. (Lamontagne and Rice 1995)

This constraint maintains the integrity of a segment by requiring that the Root nodes of the input and output correspond. This also prevents the redistribution of input features to other Root nodes, as the one-to-one relation is violated.

There is another constraint which plays a crucial role in selecting the optimal outputs in (12). The constraint is given in (17), which rules out a sequence of nasal and /g/ within a syllable.

(17) *[+nasal]g]$_\$$

The required ranking of the constraints above is recorded here:

(18) Constraint Hierarchy
*[...n{k, g}...]$_{\text{foot/monomorpheme}}$, PARSE (14), *[+nasal]g]$_\$$ $\gg$ SPREAD, *MC

Tableau (19), for example, shows how the constraints in (18) work in order to produce correct outputs. In this tableau and henceforth, columns separated by a dotted line (such as *[...n{k, g}...]$_{\text{foot/monomorpheme}}$ and *[+nasal]g]$_\$$) do not conflict and so are not crucially ordered. Besides, < > indicates segments which are not phonetically realized, and periods represent syllable boundaries. Among the candidates in (19), only candidate (c) survives the top-ranked constraints, so that it emerges as optimal in spite of its violations of the lower ranked constraints SPREAD and *MC. Note that here, the optimal candidate is not a PARSE violation because [ŋ] in the output corresponds with both /n/ and /g/ in the input; i.e., it contains features from both of them. Although it violates *MC (i.e., its Root node has a double correspondence), this violation has no bearing on the outcome, since constraint *MC is low ranked.

(19)

	*[...n{k, g}...]$_{f/m}$	*[+nas]g]$_{\$}$	PARSE	SPREAD	*MC
a. ang.ma	*!	*			
b. aŋg.ma V [+velar]		*!		*	*
☞ c. aŋ<g>.ma V [+velar]				*	*
d. an<g>.ma			*!		

Finally, it is well known that unlike velars, labials undergo Nasal Assimilation without any special reference to stress. In other words, as discussed above, Nasal Assimilation applies with velars only in certain environments (i.e., within the monomorpheme or foot), but it applies freely with labials in any stress environment, as shown in (20).

(20) compóse còmposítion compósite cómpetent compártment
sýmbol symbólic sýmpathy simpático impóssible

It has been a common assumption in previous analyses that in (20), the nasal consonant /n/ receives its place feature from the following obstruent by the rule of Nasal Assimilation. Under the analysis adopted in this paper, we can account for this by adding another constraint in (21) to the constraint hierarchy of English, which bans a sequence of /n/ and labial.

(21) *n[+labial]

Constraint (21) is undominated, so that it should not be violated in any optimal output. For example, the tableau in (22) illustrates how this constraint conspires with other constraints in selecting optimal outputs. Candidate (a) violates highly ranked constraint *n[+labial], whereas candidate (b) satisfies it. Therefore, candidate (b) emerges as optimal although it contains violations of low-ranked constraints SPREAD and *MC.

(22)

	*n[+lab]	*[...n{k, g}...]$_{f/m}$	*[+nas]g]$_{\$}$	PARSE	SPREAD	*MC
a. inpossible	*!					
☞ b. impossible V [+lab]					*	*

So far I have claimed that nasal assimilation in English can be given a natural account in terms of identity relation between input and output.

In what follows, I will show that a standard Optimality Theoretic (Prince and Smolensky 1993) account, where faithfulness between input and output is construed structurally in terms of the over- and underparsing of the input string, cannot handle the phenomena under discussion properly. Although such an account could account for the nasal assimilation in (3), (4) and (20) straightforwardly, it would make a wrong prediction in (12), as exemplified in (23). Here, since candidate (a) violates constraints $*[\ldots n\{k,\ g\}\ldots]_{foot/monomorpheme}$ and $*[+nasal]g]_{\$}$, it is excluded from consideration immediately. The remaining three parses (b, c, d) are not distinguished by the top-ranked constraints; i.e., they tie in violating one of the constraints each (Note that both (23c) and (23d) violate Parse (Prince and Smolensky 1993), for /g/ is unparsed.). Thus the next constraint down the hierarchy, SPREAD, becomes relevant. Candidates (b) and (c) fail but candidate (d) passes it. As a result, candidate (d) would be incorrectly selected as optimal.[6]

(23)

	$*[\ldots n\{k,\ g\}\ldots]_{f/m}$	$*[+nas]g]_{\$}$	Parse (P & S 1993)	SPREAD
a. ang.ma	*	*!		
b. aŋg.ma V [+velar]		*		*!
c. aŋ<g>.ma V [+velar]			*	*!
d. an<g>.ma			*	

4. Conclusion

To sum up, reconsidering nasal assimilation in English within the framework of OT, I have shown that a purely constraint-based approach can account for the phenomena in a natural way, overcoming some drawbacks of the earlier analyses. I have also argued against an account based on structural interpretations of faithfulness, and proposed that identity relation between input and output (i.e., *correspondence*) provides the best account. In addition, I have presented further evidence that as Lamontagne and Rice (1995) assert, it is necessary to extend correspondence to the featural level.

Notes

* This paper was supported by Wonkwang University in 1996.

1. In English, the voiced obstruents /b/ and /g/ are deleted when tautosyllabic with a preceding nasal, as shown in (i).

(i) bomb vs. bombard
long longer

The /g, b/-deletion rule above can be stated as follows (cf. Halle & Mohanan 1985, Borowsky 1986):

(ii) /g, b/-deletion
/g, b/ → ∅ / [+nas] ___]s

2. All the data in (3) and (4) are taken from Borowsky (1986).
3. For foot construction, see Hayes (1982).
4. In a standard OT (Prince & Smolensky 1993), Parse is defined as follows:

(i) Parse: Underlying segments must be parsed into syllable structure.

5. In McCarthy and Prince (1995), the term Max-IO (Max over input/output) is used for the correspondence-based version of Parse.
6. Accounting for the examples in (12) in terms of PARSE (McCarthy and Prince 1994b) cannot predict correct outputs, either.

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