A Correspondence Account of the Alternations of English Nasal-Final Prefixes*

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Seok-keun Kang. 1999. A Correspondence Account of the Alternations of English Nasal-Final Prefixes. *Linguistics* 7-3, 157-174. The purpose of this paper is to reconsider the phonology of English nasal-final prefixes within the framework of Optimality Theory, especially in terms of *correspondence*. In this paper, I show that compared with previous analyses employing rules and their extrinsic orderings, a constraint-based approach can give a better account of the phenomenon. In order to do this, following Kenstowicz(1995), I posit a constraint of Uniform Exponence. In particular I assume that the candidates for the allomorph of a prefix are evaluated so as to minimize allomorphic difference in the realization of the morpheme itself. I show that given these assumptions, we can account for assimilation of the prefix-final nasals in a unified way by appropriately ranking the Uniform Exponence constraint among the other constraints. **(Wonkwang University)**

1. Introduction

The purpose of this paper is to consider assimilation of English prefix-final nasals within the framework of Optimality Theory (henceforth, OT; Prince & Smolensky 1993), especially making use of a relation of *correspondence* (McCarthy & Prince 1994b, 1995, Lamontagne & Rice 1995). There has been in the literature much discussion on the phenomenon (to name a few, Chomsky & Halle 1968, Kiparsky 1982,

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Borowsky 1986), none of which, however, provides a satisfactory account. In this paper, by employing the framework of OT, I will show that a constraint-based approach can give a better account of the phenomenon. In order to do this, following Kenstowicz(1995), I will posit a constraint of Uniform Exponence which evaluates sets of morphologically related words for segmental and prosodic similarity. In particular, I will assume that the candidates for the allomorph of a prefix are evaluated so as to minimize allomorphic difference in the realization of the morpheme itself. I will show that we can account for the phonology of the nasal-final prefixes in a unified way by appropriately ranking the constraint Uniform Exponence among the other constraints. That is, I will claim that no level ordering (cf. Kiparsky 1982) nor different underlying representations (cf. Borowsky 1986) need to be specified in the grammar, and that what is needed is a set of some ranked and violable constraints.

The paper proceeds as follows. Section 2 reviews earlier analyses. Section 3.1 provides a brief introduction to the principles and assumptions of OT, and section 3.2 proposes an alternative analysis of the alternations of the nasal-final prefixes, arguing for a special constraint hierarchy which produces correct outputs. Finally, section 4 summarizes the paper.

2. Previous Analyses

In this section, I will review previous analyses of assimilation of nasal-final prefixes. To begin with, consider the examples in (1)[1]. In (1a), the nasal of level 1 prefix /in-/[2] assimilates in place to the stem

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1. Most of the examples in (1)-(3) are taken from Borowsky(1986).

2. It has generally been assumed that English has two classes of affixes. *SPE* distinguishes between the affixes with '+' (close juncture) boundary and the affixes with '#' (open juncture) boundary. These two affix classes have been variably termed level 1 and 2, class 1 and 2, and stratum 1 and 2 in the literature. Here I use the terms level 1 and 2 affixes. I also use the '-'

consonant by the so-called Nasal Assimilation. In (1b), preceding sonorant-initial stems, no nasal appears in the prefix; the analysis of this case is usually considered to be total assimilation of the prefix nasal followed by degemination of the resulting sequence (cf. Borowsky 1986 among others).

(1) a.	in-duce → i[n]duce	
	in-probable → i[m]probable	*i[n]probable
	in-crease → i[ŋ]crease	*i[n]crease
b.	in-radiant → irradiant → i[ ]radiant	*i[r]radiant
		*i[n]radiant
	in-legible → illegible → i[ ]legible	*i[l]legible
		*i[n]legible
	in-mature → immature → i[ ]mature	*i[m]mature
		*i[n]mature
	in-numerable → innumerable → i[ ]numerable	
		*i[n]numerable
c.	in-operable → i[n]operable	

As shown in (2), however, level 2 prefix /un-/ shows no obligatory alternations parallel to those found with the level 1 prefix in (1); i.e., in (2a-c), we see /un-/ appearing consistently as [un].

(2) a.	un-traditional → u[n]traditional	
	un-bind → u[n]bind	*u[m]bind[3]
	un-governable → u[n]governable	*u[]governable
b.	un-loosenable → u[n]loosenable	*u[l]loosenable
		*u[ ]loosenable

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boundary for both kinds of affixes for convenience sake. For the kinds of affixes, see Siegel(1974), Allen(1978), Kiparsky(1982), Halle & Mohanan(1985), Inkelas(1989) and others.

3. In fast speech, the nasal of /un-/ optionally assimilates in place of articulation to the following obstruent. In this paper, my discussion is limited to obligatory Nasal Assimilation.

un-retractable → u[n]retractable	*u[r]retractable
	*u[ ]retractable
un-manageable → u[n]manageable	*u[m]manageable
	*u[ ]manageable
un-natural → u[n]natural	*u[ ]natural
c. un-employed → u[n]employed	

In earlier work in lexical phonology and morphology, the general argument went like this: assimilation of the final nasal occurs with level 1 prefixes but it does not occur with level 2 prefixes. It was also argued that degemination is a feature of level 1 phonology and not of level 2 phonology. However, a problem arises for this analysis if we consider another nasal-final prefix /en-/. Observe the alternations given in (3).

(3) a. en-tangle → e[n]tangle		
en-broil → e[m]broil	*e[n]broil	
en-glacial → e[ŋ]glacial	*e[n]glacial	
b. en-rich → e[n]rich	*e[r]rich	*e[ ]rich
en-lighten → e[n]lighten	*e[l]lighten	*e[ ]lighten
en-mesh → e[n]mesh	*e[m]mesh	*e[ ]mesh
en-noble → e[n]noble		*e[ ]noble
c. en-act → e[n]act		

As exemplified in (3a), /en-/ shows similar behavior to /in-/ in that the nasal obligatorily assimilates to the following obstruent. Preceding sonorants as shown in (3b), however, there is neither total assimilation nor degemination found in (1b). In this respect, it is like /un-/. Therefore, it is unclear phonologically to which level (à la Kiparsky 1981, 1982) this prefix belongs. The morphology associated does not throw much light either. That is, /en-/ attaches only to words but not to root, which suggests that it is a level 2 prefix like /un/. Yet it attaches inside of level 1 suffixes (e.g., [[en[capsul]]ate]), suggesting that it is a level 1 prefix like /in/.[4] Therefore, as Borowsky(1986) points out, the argument for level ordering as the sole explanation becomes dubious in its own right; i.e., it is not possible to account for the alternations of the prefixes in a natural way by invoking the notion level ordering.

Borowsky(1986) claims that the prefixes behavior with respect to the processes mentioned above follow from their underlying representations rather than from anything about level ordering. In order to account for the facts above, she assumes that the three prefixes actually have different underlying forms as shown in (4). According to her, the nasal of /in-/ is not a nasal underlyingly at all, but rather it is a sort of archi-sonorant which will appear as a nasal or a sonorant on the surface.

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(4) a. /in-/ : V   C     b. /un-/ : V   C         c. /en-/ : V   C
               |   |                |   |                    |   |
               ɪ [+son]             ʌ [+nas, +cor]           ɛ  [+nas]
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She also proposes three default rules given in (5) and the assimilation rule given in (6).

(5) a. [nasal] → [α nasal] / [___, α son]
b. [son] → [β son] / [___, β nasal]
c. [ ] → [+cor]

(6) Assimilation

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    x   x
     ⋱  |
    [place]
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For example, the following derivations illustrate how 'improve',

4. For the possible ordering of morphological processes in word-formation, I refer the reader to Siegel(1974), Allen(1978) and Kiparsky(1982) among others.

'embody', and 'unprobable' are derived.[5] (Here, s = sonorant; c = coronal; n = nasal)

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(7) a. in - prove
     C - C   →  C -  C (Ass.) →     C  -    C  (5a)
     |   / \    / \  / \            / | \   / | \
    [+s] [-c][-s] [+s][-c][-c][-s]     [+s][+n][-c] [-s][-n][-c]
    b. en - body
     C - C   →  C - C (Ass.) →  C   -   C  (5a, b)
     |   / \    / \  / \        / | \   / | \
    [+n] [-c][-s] [+n][-c][-c][-s]  [+s][+n][-c] [-s][-n][-c]
    c. un - probable
     C  - C  (Ass. n. a.)  →   C   -   C  (5a, b)
    / \   / \                 / | \   / | \
   [+n][+c] [-c][-s]           [+s][+n][+c] [-s][-n][-c]
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In (7a), Assimilation applies, inserting feature [-coronal] in the first C. Then, the default rule in (5a) applies. In (7b), after Assimilation applies, the default rules (5a) and (b) also apply. But in the case of (7c), no assimilation rule applies.

However, her analysis also has certain shortcomings. First, she has to posit three different underlying representations for one and the same phoneme /n/, which is unconvincing. Second, according to her, the assimilation rule in (6) has the effect of inserting place features lexically, but postlexically it also applies in a feature changing fashion. It is unreasonable to assume that a rule can apply in two different ways depending upon levels. Finally, she asserts that the unmarked sonorant be a nasal and that the default rule in (5b) fill in the value [+nasal] in (4a). However, there are some other sonorants such as /l/ and /r/ which are not [+nasal]. In these cases, if the default rule were

5. Borowsky(1986) places different morphemes on separate planes. But here I place them on the same plane for the sake of simplicity.

to apply, an ill-formed feature matrix (e.g., *[+nasal, +lateral, +sonorant]) would be produced.

In what follows, I will show that the alternations of the prefixes above can be accounted for in a natural and unified way once an OT framework is employed.

3. An Alternative Analysis

3.1. Optimality Theory

As noted above, in this paper, I consider the alternations of English nasal-final prefixes 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*. Therefore, before I proceed to an OT account of the facts, I will first provide a brief introduction to OT and the identity relation. OT espoused by Prince and Smolensky(1993) is a purely constraint-based approach to phonological well-formedness. OT says that there are no phonological rules but well-formedness constraints on the surface forms. In this theory, Universal Grammar provides a set of highly general well-formedness constraints. Languages differ in how they rank these often conflicting constraints in strict dominance hierarchies; the constraints are ranked on a language-particular basis. Constraints are in principle violable, but violation is minimal. OT maintains that phonological generalizations can be treated by a two-step process given in (8).

(8) a. Gen (In_k) → {Out_1, Out_2, ...}
    b. Eval (Out_i, $1 \leq i \leq \infty$) → Out_{real}

First, the Gen operation generates all possible candidates for a given input. Then Eval determines the relative harmony of the candidates in terms of a hierarchy of constraints. An optimal output is the one that best satisfies the constraint hierarchy. Best-satisfaction of the constraint hierarchy is computed over the whole hierarchy and the whole candidate set.

Turning now to the notion *correspondence*, it is a relation between two structures, such as base and reduplicant or input and output. McCarthy and Prince (1994b) formally define the correspondence relation as follows:

(9) Correspondence[6]

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, $\alpha = f(\beta)$.

The notion correspondence is designed to capture the identity relation between the input and the output. Each candidate comes from Gen with a correspondence relation between the elements of the output and those of the input. I refer the reader to Prince and Smolensky(1993), and McCarthy and Prince(1994b) for the comprehensive view and formalization.

Given this much theoretical background, in the following section, I will provide an OT account of the phonology of English nasal-final prefixes.

3.2. A Constraint-Based Account

In this section, reconsidering the alternations in (1)-(3) within the framework of OT, I claim that a constraint-based approach can account for the phenomenon straightforwardly. In so doing, I show that no level ordering nor different underlying representations indispensable in

6. Lamontagne and Rice(1995) assert that correspondence should be extended to the featural level. For a detailed discussion, see the reference cited and also Kang(1996).

previous work need to be specified in the grammar, and that what is needed is a set of some ranked, violable constraints. In order to do this, I assume after Kenstowicz(1995) that the candidates for the allomorph of a prefix are evaluated so as to minimize allomorphic difference in the realization of the morpheme itself. The relevant constraint is given in (10).

(10) Uniform Exponence(UE): minimize the differences in the realization of a lexical item (morpheme, stem, affix, word). (Kenstowicz 1995)

Constraint (10) requires that a lexical item be uniformly realized in the output. Depending on where Uniform Exponence is ranked among the other constraints, we derive different effects.

Given the constraint above, now let us consider how we can account for the phenomenon in (1)-(3). To begin with, observe the examples in (1), some of which are repeated here in (11) for convenience.

(11) a. in-pel → i[m]pel
in-crease → i[ŋ]crease
b. in-reverent → i[ ]reverent *i[r]reverent *i[n]reverent
in-legible → i[ ]legible *i[l]legible *i[n]legible
in-mature → i[ ]mature *i[m]mature *i[n]mature
c. in-ter → inter
in-appropriate → inappropriate

As shown in (11a), the nasal of the prefix /in/ assimilates in place to the following stem-initial obstruent. (11b) shows that when followed by sonorant-initial stems, no nasal appears in the prefix. But preceding the remaining coronal-initial stems and vowel-initial stems, the prefix remains unchanged as shown in (11c). Assuming that this is the default realization of the prefix, I propose Uniform Exponence-/in/ which requires the uniform realization of the prefix as [in] in the output. Any modification of the prefix (e.g., assimilation and deletion of the nasal) will incur a violation of the constraint. In what follows, I will show how this constraint conspires with the other constraints to produce correct outputs.

First, consider the alternations in (11a), where the nasal of the prefix /in-/ shares place features with the following obstruents. In order to account for this, I formulate the relevant constraint as follows:

(12) $Nasal^{Place}$: Nasals must share place features with the following consonants.

Constraint (12) penalizes nasals which are not homorganic with the following consonants. That is, in the case at hand, the constraint requires that the nasal of the prefix /in/ share the place feature of the stem-initial consonant. However, changing place features incurs a cost, namely violations of Uniform Exponence-/in/ and IDENT-IO(place) in (13).

(13) IDENT-IO(place): Correspondent segments must have identical values for feature Place.

I further assume after Prince and Smolensky(1993) that the function Gen has the power to delete segments (i.e., underparsing of segments), but that deletion of segments results in a violation of the following constraint.

(14) MAX-IO: Every segment of the input must have a correspondent in the output. (McCarthy & Prince 1995)

The constraint MAX-IO is a constraint against nonparsing of underlying segments; deleted segments count as MAX-IO violations. In order to get the correct results in (11a), $Nasal^{Place}$ and MAX-IO should be ranked over IDENT-IO(place) and Uniform Exponence-/in/. For example, the tableau below exemplifies how the constraints above work to produce the correct output impress from its input in - press. In this tableau, and henceforth, constraints are ordered from left to right in order of priority. Columns separated by a dotted line (e.g., Uniform Exponence-/in/ and IDENT-IO(place) in (15)) do not conflict and so are not crucially ordered. * indicate violations, and ! signals fatal violations. The pointing hand indicates optimal candidates. In addition, cells which do not participate in the decision are shaded.

(15) Input: in-press

Candidates	Nasal^{Place}	MAX-IO	UE-/in/	IDENT-IO(place)
a. inpress	*!			
☞ b. impress				
c. ipress		*!		

Candidate (15a) contains a consonant cluster /np/, which incurs a fatal violation of the top-ranked constraint Nasal^{Place}. (15a) is excluded from consideration immediately, since non-violating candidates exist. Of the two surviving candidates, candidate (15b) passes but (15c) fails MAX-IO, and so the former emerges as optimal. Note that candidate (15b) fails Uniform Exponence-/in/ because it contains [im], and it also violates IDENT-IO(place) because the place feature of the nasal has been changed. However, candidate (14b) is selected as optimal in spite of these violations, for it satisfies the high-ranked constraints Nasal^{Place} and MAX-IO.

For the cases in (11b), two more constraints come into play. These phonotactic constraints are as follows:

(16) *[+nasal][+sonorant][7]

7. Vowels are also [+sonorant]. But note that sonority is not distinctive for vowels. Thus I assume that vowels are represented with the [sonorant] feature unspecified. (cf. Archangeli 1984)

(17) No-Geminate: There should be no geminate consonants in the output.

Constraint (16) requires that there be no sequence of nasal and sonorant in the output. This constraint is ranked high, accounting for why sequences such as *[nr] in (11b) are not allowed.[8] In English, in addition, consonant length is not distinctive; i.e., geminate consonants are not part of the phoneme inventory. Geminate consonants in the output are ruled out by the constraint No-Geminate. The constraints in (16) and (17) should outrank MAX-IO and Uniform Exponence-/in/ to produce optimal outputs in (11b). Tableau (18) exemplifies how the constraints discussed above work to produce correct outputs.

(18) input: in-reverent

Candidates	*[+nas][+son]	No-Geminate	MAX-IO	UE-/in/
a. inreverent	*!			
☞ b. ireverent				
c. irreverent		*!		

(18a) contains a sequence of nasal and sonorant, violating high-ranked *[+nasal][+sonorant], which is fatal. (18c) fails No-Geminate because of [rr], and it also violates Uniform Exponence-/in/ due to the realization of the prefix /in/ as [ir]. The optimal output is (18b) which satisfies both of the high-ranked constraints. Even though it violates the low-ranked constraints MAX-IO and Uniform Exponence-/in/, these violations have no effect on the outcome.

Lets turn now to the cases of the prefix /un/ in (2), some examples

8. Nasals can be followed by sonorants morpheme-internally as in 'only', 'henry', etc. The nasal-sonorant sequences in these cases will violate *[+nasal][+sonorant]. However, these violations may be tolerated to gain success on the higher-ranked constraint Uniform Exponence(stem). (cf. McCarthy & Prince 1995, Kenstowicz 1995)

out of which are repeated here as (19) for convenience. It has been shown that the prefix shows no obligatory alternations parallel to those found with the prefix /in/. That is, it does not assimilate to the following nonsonorant (19a), nor does it undergo deletion when followed by sonorants (19b).

(19) a. un-bind → u[n]bind *u[m]bind
b. un-loosenable → u[n]loosenable *u[ ]loosenable *u[l]loosenable
un-natural → u[n]natural *u[ ]natural

We can account for these facts by ranking Uniform Exponence-/un/ over all the other constraints proposed above. That is, the required ranking of the constraints is as follows[9]:

(20) Interim Constraint Hierarchy:
Uniform Exponence-/un/ ≫ Nas^{Place} ≫ *[+nasal][+sonorant], No-Geminate ≫ MAX-IO ≫ Uniform Exponence-/in/, IDENT-IO(place)

Given the constraint hierarchy above, the phonology of the prefix /un-/ can be accounted for in a natural way. The following tableaux, for example, illustrate how the correct outputs in (19) are produced. It is clear from these tableaux that Uniform Exponence-/un/ plays a decisive role in selecting the optimal outputs. This constraint is undominated, and so any violation of this constraint is fatal. In (21), to begin with, candidate (a) meets Uniform Exponence-/un/, while candidate (b) fails it due to the change of /un/ into [um]. Hence, (a) is selected as optimal. In (22), candidates (b) and (c) violate the top-ranked constraint Uniform Exponence-/un/, which is fatal. Only candidate (a) satisfies this constraint, and so it emerges as optimal. In (23), candidate (a) satisfies Uniform Exponence-/un/. However,

9. In (20), A B means that A is more highly ranked than B.

candidate (b) violates it, for the nasal of the prefix is unparsed. As a result, candidate (a) is the optimal output.

(21) input: un-bind

Candidates	UE-/un/	Nas^{Place}	*[+n][+s]	No-Gem	MAX-IO	UE-/in/	IDENT-IO(pl)
☞a. unbind							
b. umbind	*!						

(22) input: un-retractable

Candidates	UE-/un/	Nas^{Place}	*[+n][+s]	No-Gem	MAX-IO	UE-/in/	IDENT-IO(pl)
☞ a. unretractable							
b. uretractable	*!						
c. urretractable	*!						

(23) input: un-natural

Candidates	UE-/un/	Nas^{Place}	*[+n][+s]	No-em	MAX-O	UE-/in/	IDENT-IO(pl)
☞ a. unnatural							
b. unatural	*!						

Up to now, I have shown that the phonology of prefixes /in-/ and /un/ can be accounted for in a unified way in terms of OT.

Now let us consider the alternations of the prefix /en-/, which was problematic under the previous analyses. As discussed above, it is unclear phonologically to which level this prefix belongs; hence it is not possible to account for the alternations of the prefix /en-/ in terms of level ordering. It is also unreasonable to posit different underlying representations like Borowsky(1986). In what follows, I propose an alternative analysis which capitalizes on the assumption discussed above, showing that the phonology of the prefix /en-/ is directly related to the ranking of Uniform Exponence-/en/ with respect to the other constraints. First, let us consider the cases in (3a), where the nasal of the prefix /en-/ assimilates in place to the following obstruents (e.g., en-broil e[m]broil, *e[n]broil). For the case at hand, Nas^{Place} must dominate Uniform Exponence-/en/ and IDENT-IO(place) in order to produce correct outputs. For example, tableau (24) illustrates how the output embroil is produced from its input 'en-broil'.

(24) input: en - broil

Candidates	NasPl	UE-/en/	IDENT-IO(pl)
☞ a. embroil		[redacted]	[redacted]
b. enbroil	*!	[redacted]	[redacted]

In the tableau above, candidate (a) is selected as optimal in spite of its violations of Uniform Exponence-/en/ and IDENT-IO(place) because of [em], for it crucially obeys high-ranking $Nasal^{Place}$, which the alternative candidate (b) violates. As illustrated in (24), $Nasal^{Place}$ must dominate Uniform Exponence-/en/. If we were to reverse the domination ranking of these constraints, an incorrect output 'enbroil' would be selected as optimal.

Now lets consider the examples in (3b), which shows that when /en-/ is concatenated to sonorant-initial stems, neither assimilation nor deletion occurs (e.g., 'en-rich' → e[n]rich *e[r]rich, *e[ ]rich). As exemplified in the following tableau, we can account for this by ranking Uniform Exponence-/en/ over the phonotactic constraints *[+nasal][+sonorant], No-Geminate, and Faithfulness constraint MAX-IO.

(25) input: en-rich

Candidates	Nas^{Place}	UE-/en/	*[+n][+s]	No-Gem	MAX-O	IDENT-O(pl)
☞ a. enrich						
b. erich		*!				
c. errich		*!				

In (25), although candidate (a) violates *[+nasal][+sonorant], it emerges as optimal, since it satisfies high-ranked constraint Uniform Exponence-/en/ which candidates (b) and (c) violate.

So far, considering the phonology of nasal-final prefixes in the framework of OT, I have argued that the phenomenon can be accounted for in a unified way under the constraint hierarchy in (26).

(26) Final Constraint Hierarchy
Uniform Exponence-/un/ ≫ Nas^{Place} ≫ Uniform Exponence-/en/ ≫ *[+nasal][+sonorant], No-Geminate ≫ MAX-IO ≫ Uniform Exponence-/in/, IDENT-IO(place)

4. Conclusion

To sum up, in this paper I have considered some theoretical devices for handling assimilation of nasal-final prefixes, and have claimed that the actual parse is indeed optimal as determined by the constraint hierarchy (26).

The constraint-based account of the phonology of nasal-final prefixes adopted in this paper is preferred over previous analyses in that it not only dispenses with level ordering but it also obviates the need to posit different underlying representations. What I have claimed is that the phonology of English nasal-final prefixes is directly related to a hierarchy of some ranked and violable constraints.

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