An Optimality Theoretic Account of English Affixation*

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Kang, Seok-keun. 2002. An Optimality Theoretic Account of English Affixation. *The Linguistic Association of Korea Journal, 10*(3), 1-24. The purpose of this paper is to present a constraint-based account of affixation processes in English. Firstly, I assert that the relative ordering of affixes in multiply-affixed words can be accounted for in a unified way by making use of several ranked and violable alignment constraints. In particular, considering the so-called bracketing paradoxes, I claim that prefixation and suffixation be independent of each other so that an affix can be prefixed or suffixed to the base once its selectional requirements are met. Secondly, I show that when affixes of the same class occur in a word, a set of SUBCAT constraints plays a crucial role in selecting optimal output. Finally, in order to account for the determination of word categories, I distinguish between prefixes and suffixes in terms of 'headedness', as well as between roots and suffixes, and show that given the distinctions, determination of word categories follows from the theory.

Key words: prefix, suffix, base, affixation, class, constraint, alignment, percolate, head, subcategorization, selectional requirement

1. Introduction

The aims of this paper are (i) to account for how grammar governs the distribution of affixes in multiply-affixed words and (ii) to discuss how the categories of words resulting from affixation are determined. Considering the ordering of affixes in multiply-affixed words within the framework of Optimality Theory (Prince & Smolensky 1993; McCarthy

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& Prince 1995), I will show that the distribution of affixes relative to each other is derivable from independently motivated constraints. I will also claim that the determination of word categories follows from the theory.

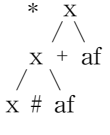
Discussing the interaction between class 1 and 2 affixes, I will first show that their relative ordering can be given a straightforward account in terms of several ranked and violable alignment constraints. One of the perplexing problems I will deal with is the bracketing paradoxes, which arise when attachment of class 1 affixes seems to presuppose the presence of class 2 affixes, or when class 2 affixation requires reference to the internal bracketing of a word that is only available at level 1 (cf. Williams 1981a; Strauss 1982; Kiparsky 1982; Pesetesky 1985). There have been many attempts to solve these problems, but none of them have provided a satisfactory account. In order to account for the bracketing paradoxes, I will assume after Strauss (1982) that prefixation and suffixation are independent of each other. Given this assumption, for example, attachment of class 2 prefix *un-* before class 1 suffix *-ity* in *ungrammaticality* will not cause any problems because the selectional requirements of both affixes are satisfied by the base *grammatical*. Regarding cases like $*in_1\text{-}success\text{-}ful_2$, I will propose the constraint SUBCAT1↛2, which bans class 1 prefixes from subcategorizing for class 2 suffixes. This constraint correctly rules out **insuccessful* in favor of *unsuccessful*. Second, I will show that the requirement that derivational affixes should occur inside of inflectional affixes can be enforced by ranking ALIGNDERSUF over ALIGNINFSUF. Third, considering cases where affixes of the same class occur together in a word, I will claim that the ordering is a result of the enforcement of unviolable SUBCAT constraints. Finally, I will discuss how the categories of output forms are determined, and show that the differences between prefixes and suffixes with respect to 'headedness' can be captured by having a set of PERCOLATE constraints.

The paper is organized as follows: section 2 discusses the Affix Ordering Generalization and bracketing paradoxes. Section 3 deals with subcategorization requirements of affixes, and section 4 addresses the

way in which the categories of the resulting words are determined. Finally, section 5 summarizes the paper and discusses some remaining issues.

2. Affix Ordering

Traditionally, English affixes are classified into two groups – i.e., class 1 and class 2 – on the basis of their phonological behaviour (cf. Chomsky & Halle 1968; Kiparsky 1982; Halle & Mohanan 1985; Borowksy 1986). Class 1 affixes are phonologically non-neutral; they affect in some way the consonant or vowel segments, or the location of stress in the base to which they are attached (e.g., *cýclic* vs. *cyclícity*; *keep* vs. *kept*). On the other hand, class 2 affixes are neutral because they have no phonological effect on their base (e.g., *abándon* vs. *abándonment*; *peep* vs. *peeped*). Regarding the interaction between the two types of affixes, Siegel (1974) argues for the Affix Ordering Generalization (henceforth, AOG), which says that class 1 affixes can appear inside of class 2 affixes (e.g., *non$_2$-il$_1$-legible*[1], *danger-ous$_1$-ness$_2$*), but class 2 affixes cannot appear inside of class 1 affixes (e.g., **in$_1$-non$_2$-legible*, **tender-ness$_2$-ous$_1$*). That is, no derivations such as (1)[2] are possible.

(1)


1) The /n/ of the prefix *in-* assimilates to the following /l/. For a traditional account, see Halle and Mohanan (1985) and Borowsky (1986), and also for an OT approach, see Kang (2000).

2) In *SPE*, the difference between the behaviour of neutral and non-neutral affixes was dealt with in terms of the strength of boundaries; i.e., a weak boundary (symbolized by '#') was said to intervene between the base and a neutral affix, while a strong boundary (symbolized by '+') was assumed to separate the base from a non-neutral affix.

The AOG is a descriptive statement about the ordering of classes of affixes: class 1 affixes must appear closer to the root than class 2 affixes (Siegel 1974; Sproat 1985; Fabb 1988). This is why, for instance, *non*$_2$-*il*$_1$-*legible* is possible, while **in*$_1$-*non*$_2$-*legible* is not. In both cases, the prefixes *il/in-* and *non-* satisfy their subcategorization requirements. The only difference is that *non-il-legible* has the ordering [class 2 - class 1 - root], while **in-non-legible* is [class 1 - class 2 - root]. In what follows, I will show that the position of affixes relative to each other need not be expressed by elaborate rule ordering mechanisms. Rather I will assert that it follows from the interaction of some ranked, violable alignment constraints.

With respect to the AOG, there are two aspects to consider. First, the AOG prohibits class 2 affixes from appearing closer to the root than class 1 affixes when both types are attached together as prefixes or suffixes, as seen in (2a, b). Second, regarding the interaction between prefixes and suffixes, the AOG also dictates that class 1 affixes should be attached to the root before class 2, as shown in (2c, d).

(2) a. [[root - class 1] class 2] *[[root - class 2] class 1]
b. [class 2 [class 1 - root]] *[class 1 [class 2 - root]]
c. [class 2 [root - class 1]] *[[class 2 - root] class 1]
d. [[class 1 - root] class 2] *[class 1 [root - class 2]]

In the present analysis, the cases in (2a, b) can be accounted for in a straightforward way by having a set of generalized alignment constraints (cf. McCarthy & Pirnce 1993). Specifically, I propose the following constraints:

(3) a. ALIGNCLASS1PRE: Align(class 1 prefix, right; root, left)
b. ALIGNCLASS2PRE: Align(class 2 prefix, right; root, left)
(4) a. ALIGNCLASS1SUF: Align(class 1 suffix, left; root, right)
b. ALIGNCLASS2SUF: Align(class 2 suffix, left; root, right)

A word structure satisfying the constraints (3a, b) is one in which the

right edge of a prefix coincides with the left edge of a root. In like manner, the constraints in (4a, b) govern the concatenation of a suffix with a root, demanding alignment of the left edge of a suffix with the right edge of a root. Assuming that there are separate sets of correspondence constraints for each affix class, Benua (1997) claims that correspondence constraints that refer to class 2 affixes always dominate those that refer to class 1 affixes.[3] In what follows, however, I will show that when it comes to the alignment of affixes, the reverse is true: that is, constraints requiring alignment of class 1 affixes take precedence over constraints requiring alignment of class 2 affixes. In other words, ALIGNCLASS1 constraints always outrank ALIGNCLASS2 constraints. Given this ranking, an account of (2a) is straightforward. Consider, for example, tableau (5), where *-ian* and *-ism* are class 1 and class 2 suffixes, respectively. Crucial for my analysis is the view that morphemes are unordered with respect to each other in the input and GEN freely generates different concatenations of these morphemes (cf. de Lacy 2001). In candidate (5a), which is the AOG-obeying form, ALIGNCLASS2SUF is violated: the left edge of the class 2 suffix *-ism* is not aligned with the right edge of the root *Mendel*. The AOG-violating candidate (5b), however, fares poorly in comparison: it violates the high-ranked ALIGNCLASS1SUF because the left edge of the suffix *-ian* is not aligned with the right edge of the root. As a result, candidate (5a) is more harmonic than (5b) and emerges as optimal.

(5)

{Mendel, $-ism_2$, $-ian_1$}	ALIGNCLASS1SUF	ALIGNCLASS2SUF
☞ a. Mendel-ian_1-ism_2		*
b. Mendel-ism_2-ian_1	*!	

The interaction between class 1 and 2 prefixes in (2b) can also be accounted for straightforwardly, as illustrated in (6). (6a) is selected as the optimal output in spite of its violation of ALIGNCLASS2PRE, because it obeys the

3) For detailed discussion, see Benua (1997).

high-ranked constraint ALIGNCLASS1PRE which its contender fatally violates.

(6)

{non$_2$-, in$_1$-, legible}	ALIGNCLASS1PRE	ALIGNCLASS2PRE
☞ a. non$_2$-il$_1$-legible		*
b. in$_1$-non$_2$-legible	*!	

So far, I have shown that when class 1 and 2 affixes occur together as prefixes or suffixes in a word, the ordering requirement that holds between them will follow if constraints on the alignment of class 1 affixes outrank constraints on the alignment of class 2 affixes,

Let us now consider the interaction between prefixes and suffixes in (2c) and (2d). I will first discuss (2c), which is traditionally known as a bracketing paradox because the semantically justified bracketing clashes with what the morphology seems to require. To take an example, consider the word *ungrammaticality*. The class 2 prefix *un-*, which has the meaning of 'not', is only prefixed to adjectives, producing derived adjectives (e.g., *unkind* [*un* [*kind*]$_A$]$_A$ vs. **untree* *[*un* [*tree*]$_A$]$_A$)[4]. Recall that the class 1 suffix *-ity* attaches to adjectives to form nouns. *Grammatical* is an adjective so that *-ity* can be suffixed to it, producing *grammaticality* [[*grammatical*]$_A$ *ity*]$_N$. Note that two crucial tenets of lexical morphology are (i) that the ordering of levels in the lexicon entails an ordering of processes such that level 1 word-formation processes precede their level 2 counterparts (cf. Allen 1978; Siegel 1974; Pesetsky 1979; Kiparsky 1982, 1985; Mohanan 1982, 1986), and (ii) that at the end of each layer of derivation, information concerning bracketing and any morphological, phonological or other properties internal to the word is obliterated by the Bracket Erasure Convention (cf. Pesetsky 1979; Mohanan 1982). Given the above assumptions, the adjective bracket

4) There is another *un-* prefix which has a reversive meaning and attaches to verbs (as in *unpeg*). As this prefix is not germane to the present argument, I will ignore it.

of [*grammatical*]$_A$ will have been removed by the time the derivation reaches level 2 in readiness for the prefixation of *un-*, as seen in (7). Since only the noun external bracket introduced by *-ity* will be visible in the noun *grammaticality*, it should not be possible to combine it with *un-*, which requires an adjective base. However, it does.

(7) level 1: [grammatical]$_A$
↓
[[grammatical]$_A$ ity]$_N$
(→ [grammaticality]$_N$)
level 2; [un [grammaticality]$_N$]

Before showing how my analysis applies to the bracketing paradoxes, I will briefly review previous analyses, couched in the framework of lexical morphology. Several ways of dealing with such exceptions have been discussed. To begin with, Kiparsky (1982) proposes to allow exceptional deferral of Bracketing Erasure for particular words. On this hypothesis, *grammaticality* is formed at level 1 but idiosyncratically retains its internal bracketing [[*grammatical*]$_A$ *ity*]$_N$ so that word-formation processes can apply to the inner constituent at level 2. This approach, however, is untenable because it allows for exceptional deferral of Bracketing Erasure only for particular words. Mohanan (1982, 1986) argues for a loop device, which allows the output of a later level to re-enter an early level of derivation. According to him, *grammatical* is formed at level 2 and then fed back into level 1 where the suffix *-ity* can then be added to it (i.e., *grammatical* → *un#grammatical* (level 2) → *ungrammatical+ity* (level 1)). This approach is also problematic in that level recursion could be extended to arbitrary violations of level-ordering, which amounts to a substantial weakening of the theory. Finally, Siegel (1974) assumes that *un-* is a level 1 prefix. If this were the case, *un-* could be added to the base *grammatical* prior to the suffix *-ity*. There are, however, some factual arguments which make this approach untenable; for example, unlike other level 1 prefixes, *un-* is never subject to phonological assimilation (e.g., *in* + *possible* → *impossible* vs. *un # pack* ↛ **umpack*). For further discussion, I refer the reader to the cited references

herein and Kang (2002).

Turning now to a constraint-based account of the phenomenon under consideration, I will show that in a parallel theory, the bracketing paradoxes evaporate in an obvious way; there is no serial derivation, so there is no reason to expect that a class 2 prefix cannot appear inside a class 1 suffix. To this end, I will adopt Strauss's (1982) assertion that prefixation and suffixation are independent of each other. Given this assumption, the order of affixation in a word like *ungrammaticality* is free to reflect the selectional generalizations, so that the class 2 prefix *un-* attaches to the adjective *grammatical*, and the class 1 suffix *-ity* turns that adjective into a noun. (8), for example, shows how the constraints discussed above cooperate to produce the correct output *ungrammaticality* from its input {*un-*, *-ity*, *grammatical*}. Recall that morphemes are assumed to be unordered with respect to each other in the input and that Gen is allowed to scramble them in any order. Candidate (8a) satisfies both of the relevant constraints, while its competitor incurs a critical violation of the constraint ALIGNCLASS2PRE. Hence (8a) is selected as optimal.

(8)

{un$_2$-, -ity$_1$, grammatical}	ALIGNCLASS2PRE	ALIGNCLASS1SUF
☞ a. un$_2$-grammatical-ity$_1$		
b. grammatical-ity$_1$-un$_2$	*!	

It is clear from the above that once prefixation and suffixation are assumed to be independent of each other with respect to ordering, the bracketing paradoxes can be accounted for straightforwardly in a constraint-based approach. In the case of *ungrammaticality*, the base *grammatical* satisfies the selectional requirements of the affixes *un-* and *-ity*, which require an adjective base. Therefore, attachment of the class 2 prefix *un-* to the base *grammatical* is not problematic, nor is attachment of the class 1 suffix *-ity*. Now the question with which we are faced is how to rule out the words in (9c), compared with those in (9b).

(9) a. [[il-logical] ly]

b. ungraceful	unmerciful	unchildish
c. *[in [grace-ful]]	*inmerciful	*inchildish

As shown in (9a), class 1 prefixes can occur inside of class 2 suffixes, as predicted under the present analysis. The words in (9b) are also allowed, because the class 2 suffixes *-ful* and *-ish* meet the subcategorization requirements of the class 2 prefix *un-*. The seemingly problematic cases are (9c), which have the morphological structure *[[class 1 [root - class 2]]. Given the assumption that there is no ordering requirement between prefixes and suffixes, the words in (9c) should be acceptable, which is not the case. Does this mean that we should discard the above assumption? The answer is definitely no. If we gave up the assumption, there would be no possible way to account for the paradoxical cases mentioned above. The solution to the problem can be sought in the interaction between prefixes and suffixes with respect to selectional requirements. In the case at hand, the following constraint is in force:

(10) SUBCAT1↛2: Class 1 prefixes cannot subcategorize for class 2 suffixes.

The constraint SUBCAT1↛2 plays a pivotal role, for example, in ruling out **ingraceful* in favor of *ungraceful*, as seen in the tableau below:

(11)

	SUBCAT1↛2	ALIGNCLASS1 PRE	ALIGNCLASS2 PRE
☞ a. un_2-grace-ful_2			
b. in_1-grace-ful_2	*!		

(11a) satisfies the top-ranked constraint SUBCAT1↛2, emerging as optimal. That is, the prefix *un-* requires an adjective base, and the suffix *-ful* changes the noun *grace* into an adjective, producing an appropriate base

for *un-*. This process, however, does not result in a violation of the constraint in (10), since the prefix *un-* is class 2, not class 1. On the other hand, (11b) violates SUBCAT1↛2 due to class 1 prefix *in-* subcategorizing for class 2 suffix *-ful*.

The question I will now address concerns the interaction between derivational and inflectional morphemes. Katamba (1993) claims that where both derivational and inflectional morphemes are affixed as prefixes or suffixes, derivational morphemes occur nearer to the root than inflectional morphemes. Since English has no inflectional prefixes, the relationship between derivational and inflectional prefixes will not be considered in this paper. Instead, examining only the interaction between derivational and inflectional suffixes, I will show that the relative ordering between them can be captured by making use of both ALIGNDERSUF (12), which requires the left edge of a derivational suffix to be aligned with the right edge of the root, and ALIGNINFSUF (13), which requires the alignment of an inflectional suffix with the root.

(12) ALIGNDERSUF: Align(derivational suffix, left; root, right)
(13) ALIGNINFSUF: Align(inflectional suffix, left; root, right)

Given the ranking ALIGNDERSUF ≫ALIGNINFSUF, for example, tableau (14) shows how the optimal output *workers* is produced from its input {*work*, *-er*, *-s*}. The candidates that are of present interest are shown below:

(14)

{work, -er, -s}	ALIGNDERSUF	ALIGNINFSUF
a. work-s-er	*!	
☞ b. work-er-s		*

(14a) violates ALIGNDERSUF, since the derivational suffix *-er* is not aligned with the root. Despite its violation of ALIGNINFSUF due to the misalignment of the plural suffix *-s* with the root, (14b) is selected as optimal, because a violation of ALIGNINFSUF is less fatal than a violation of

ALIGNDERSUF.

3. Selectional Requirements of Affix

In the preceding section, I have shown that alignment constraints with reference to the distinction between class 1 and class 2 affixes can be used to predict the way in which derivational affix morphemes appear in complex words. This is, however, not the only way of predicting order. In what follows, considering cases where affixes of the same class occur together in words, I will show that several other constraints are needed to regulate their ordering. Specifically, I will claim that the ordering is a result of the enforcement of unviolable constraints related with subcategorization. To illustrate, consider the examples in (15).

(15) $home_N$-$less_A$-$ness_N$ vs. *$home_N$-$ness_N$-$less_A$
$power_N$-$less_A$-$ness_N$ *$power_N$-$ness_N$-$less_A$
$care_N$-ful_A-$ness_N$ *$care_N$-$ness_N$-ful_A
$cheer_N$-ful_A-$ness_N$ *$cheer_N$-$ness_N$-ful_A

The suffixes *-less*, *-ful* and *-ness* belong to class 2. As shown in (15), they can occur together in a word, but their ordering is subject to certain restrictions. Both *-less* and *-ful* may be added to nouns to form adjectives, whereas *-ness* may be attached to adjectives to form abstract nouns. In the word-syntax tradition of morphology, it has been a common assumption that affixes can subcategorize for what they attach to in the same way that X^o heads[5] can subcategorize for their complements (cf. Aronoff 1976, Ouhalla

5) Williams (1981a) defines the notion "head" as shown in (i):

(i) If both X and the head of X are eligible members of category C, then X $\in$C $\equiv$ head of X$\in$C.

In morphology, it is generally assumed that the head of a morphologically complex word is the righthand member of that word. Thus, the head is italicized in (ii):

(ii) a. / \ b. / \
instruct *ion* re *instruct*

1991, Russell 1999). In light of the assumption above, the lexical subcategorization frames of *-less*, *-ful* and *-ness* are shown in (16).

(16) a. -less]$_A$ / N ____
b. -ful]$_A$ / N ____
c. -ness]$_N$ / A ____

(16a, b) require that both *-less* and *-ful* attach to nouns. On the other hand, the subcategorization frame of *-ness* in (16c) carries the information that the suffix requires its base to be an adjective. *$Home_N$-$ness_N$-$less_A$, for example, is ungrammatical because it violates the lexical subcategorization restriction of *-ness*; *-ness* should be attached to adjectives.

Under the present analysis, the effect of subcategorization requirements can also be captured by utilizing some alignment constraints, which require an affix to be aligned with a base. Constraints needed in the case at hand are as follows:

(17) SUBCAT-*less*: Align(-less, left; noun, right)
(18) SUBCAT-*ness*: Align(-ness, left; adjective, right)
(19) SUBCAT-*ful*: Align(-ful, left; noun, right)

Tableau (20) illustrates how the constraints above work in order to produce

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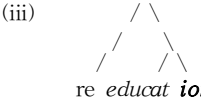
This definition is called the Righthand Head Rule (RHR). As Williams (1981a) points out, when a word has more than one affix, there is some ambiguity as to what the head is:

(iii)


Here, is *-ion*, or *education*, the head of *reeducation*? Williams (1981a) says that they both are. For the purposes of the present paper, however, I will distinguish between the root and the head by confining the notion "head" to suffixes only. More specifically, I will use the term "head" to refer to only the right-most suffix of a complex word for reasons to be discussed later. In the case of *logic-al-ly*, for example, only *-ly* will be referred to as the head.

the correct output *homelessness* from its input {*home*, *-less*, *-ness*}.

(20)

{home, -less, -ness}	SUBCAT-*less*	SUBCAT-*ness*	M-Parse	ALIGNCLASS2SUF
☞ a. $home_N$-$less_A$-$ness_N$				*
b. $home_N$-$ness_N$-$less_A$		*!		*
c. $home_N$-$less_A$			*!	
d. $home_N$-$ness_N$		*!	*	

In spite of a violation of the constraint ALIGNCLASS2SUF, (20a) is selected as optimal, because it satisfies all the top-ranked constraints. (20b, d) violate SUBCAT-*ness*, since the suffix *-ness* is attached to the noun *home*. In addition, (20c, d) violate M-Parse, which militates against deletion of morphemes, because *-ness* and *-less* are unparsed, respectively.[6)]

So far, it has been shown that selectional requirements of affixes can also be captured by a set of alignment constraints. In the following section, I will discuss how word categories are determined and how suffixes are distinguished from prefixes in this respect.

4. Determining Word Categories

Let us now consider the way in which the categories of words are determined. In this respect, suffixes are distinguished from prefixes. Suffixes determine the category of the word to which they are attached, as seen in (21).

(21) X-ism → N, V-ist → N, V-ion → N, V-er → N, A-ness → N
X-ize → V, X-fy → V
X-ish → A

6) Of course, when the input includes only two morphemes {*home*, *-less*}, the candidate *homeless* will satisfy both SUBCAT-less and M-Parse, emerging as the optimal output.

Unlike suffixation, however, prefixation does not cause category change; rather, the category of a word of the form 'prefix-X' is determined by the category of X.[7] (22), for example, lists some common prefixes, the classes of the bases to which they can be attached and the words that are thereby formed.

(22)[8]

Prefix	Word-class of input base	Meaning	Word class of output word	Example
in-	Adj	not	Adj	in-accurate
un-	Adj	not	Adj	un-kind
un-	V	reversive	V	un-tie
dis-	V	reversive	V	dis-continue
dis-	N	not	N	dis-order
dis-	Adj	not	Adj	dis-honest
dis-	V	not	V	dis-approve
re-	V	again	V	re-write
ex-	N	former	N	ex-mayor

This difference between suffixes and prefixes can be captured by using the notion of 'head'. In traditional morphology, the head of a morphologically

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7) Strauss (1982) asserts that the claim that English prefixation is not generally category-changing is false. According to him, the claim is based on two mistaken beliefs. The first is that non-category-changing formatives such as those in (i) are prefixes ("class 2"):

(i) ex-president, de-emphasize, mis-apprehend, neo-conservative, non-person, re-birth

The second mistaken belief is that latinate prefixes ("class 1") such as those in (ii) are entirely unproductive:

(ii) con-sist, de-fer, in-fer, per-sist, re-fer

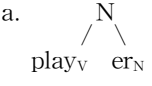
Strauss claims that a great deal of evidence exists showing that the morphemes *ex-*, *de-*, *mis-*, etc., in (i) are compound-forming elements, rather than true prefixes; that is, they behave more like free morphemes when attaching to bases than true prefixes. He also claims that the class 1 elements in (ii) are true prefixes and they do cause category-change in that they convert nonword stems to words. For detailed discussion, see Strauss (1982).

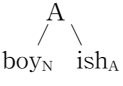
8) (22) is taken from Katamba (1993). Note that in (22), these abbreviations are used: N for noun, V fro verb and Adj for adjective.

complex word is defined to be the righthand member of that word. This definition is dubbed the Right-hand Head Rule (RHR):

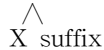
(23) Right-hand Head Rule (RHR)
In morphology we define the head of a morphologically complex word to be the right-hand member of that word. (Williams 1981a)

According to the RHR, a suffix will be the head in a structure like 'X-suffix'. Since the head is claimed to determine the properties of the whole, we expect suffixes to determine the category of the word to which they are added. As Williams (1981a) asserts, it is necessary to extend category membership to suffixes; e.g., *-ism* belongs to the category N, *-ize* to the category V, and *-ish* to the category A. Given the above assumption, an account of the generalization about the data in (21) is straightforward; the RHR applies to suffixes. The suffix, which is the head of a word, assigns its properties by percolation to the entire word, as exemplified below:

(24) a.


b.


The RHR dictates that the head of a morphologically complex word is the righthand member of that word, regardless of whether it is a root or a suffix, and it determines the properties of the whole. On the contrary, a prefix cannot be the head of the word to which it is added, since in the structure 'prefix-X' the prefix does not occupy the righthand position of the word. Given the traditional notion of 'head', a suffix will be head in the structure of (25a), but X will be head in a structure like (25b) (Williams 1981a).

(25) a.


b.


For reasons explained better, however, I will take a more restrictive stance and define 'head' as the rightmost suffix of a complex word. That is, I will

distinguish between suffix and root in terms of 'headedness'; for example, *play* in *replay* will be dubbed root, while in *player* *-er* is called head.

With this assumption in mind, let us now consider how a constraint-based approach can handle the problem of determining word classes of output. To this end, we need to invoke the notion 'percolation.' According to Russell (1999), percolation causes mothers and (at least) their head daughters to share certain features, including major category features. In light of this fact, I will claim that percolation can be achieved by enforcement of the following constraints:

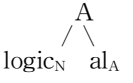
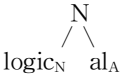
(26) PERCOLATE-ROOT: A root and its mother must have identical category features.
(27) PERCOLATE-HEAD: A mother and its head daughter suffix must have identical category features.

Clearly, PERCOLATE-ROOT is not an undominated constraint. It will be overridden if the category feature value of the root conflicts with the feature value of the head daughter. In $enlargement_{N}$, for example, it is the suffix $-ment_{N}$, not the root $large_{A}$, that determines the category of the word. Hence the relative ranking of the two constraints is as follows:

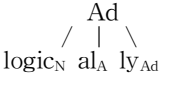
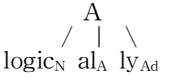
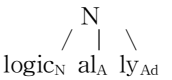
(28) PERCOLATE-HEAD 》 PERCOLATE-ROOT

The tableaux below, for example, illustrate how the constraint hierarchy in (28) works in order to produce correct output. First, consider tableau (29), which has *logic* as a root and *-al* as a head. Candidate (29a) incurs a violation of PERCOLATE-ROOT, since the category feature of the root is not percolated to the mother node. However, it emerges as optimal because its competitor violates the high-ranked constraint PERCOLATE-HEAD. When more than one suffix attaches to the root, the rightmost suffix becomes the head, determining the category of the entire word, as illustrated in (30). For the sake of simplicity, only the candidates which observe SUBCAT constraints are shown in the tableau. In (30), the first candidate carries the day, since it fares better with the top-ranked constraint PERCOLATE-HEAD than the other candidates.

(29)

{$logic_N$, $-al_A$}	PERCOL-HEAD	PERCOL-ROOT
☞ a. 		*
b. 	*!	

(30)

{$logic_N$, $-ly_{Ad}$, $-al_A$}	PERCOL-HEAD	PERCOL-ROOT
☞ a. 		*
b. 	*!	*
c. 	*!	

To sum up the discussion so far, I have shown that the rightmost suffix in a word assigns its properties by percolation to the entire word, and that this fact can be captured by ranking PERCOLATE-HEAD over PERCOLATE-ROOT.

Let us now consider prefixation. As shown above, unlike derivational suffixes, derivational prefixes generally do not bring about a shift in the grammatical class of the base to which they are attached although they modify its meaning significantly. *Kind* and *unkind* are, for instance, adjectives with opposite meanings. There are, however, a few exceptions to this generalization. One of them is the prefix *en-*, which changes not only the meaning but also the word-class of the base to which it attaches, as shown in (31).

(31) a.	Adj base	New word verb	b.	Noun base	New word verb
	able	en-able		robe	en-robe
	large	en-large		danger	en-danger
	noble	en-noble		rage	en-rage
	rich	en-rich		cage	en-cage

Sometimes *en-* is attached to adjectives as in (31a), and sometimes to nouns as in (31b).[9] Regardless of whether the base is a noun or an adjective, the crucial point here is that the prefixation of *en-* does cause a shift in the grammatical category of its base, resulting in a verb. That is, the prefix en_V- percolates its category feature value [V] to the entire word just as the rightmost head suffixes do. According to Strauss (1982), certainly *en-* is no less productive than most derivational suffixes on which the category-changing property is based. This cannot be properly accounted for by an analysis assuming the Right-hand Head Rule. The headedness of the prefix *en-*, however, does not constitute any problem to the present analysis. In order to account for the percolation of *en-*, I propose the following constraint:

(32) PERCOLATE-*en*: The prefix -*en* and its mother must have identical category features.

When the category feature value of the prefix *en-* conflicts with that of the root, the former always takes priority over the latter. The constraint PERCOLATE-*en*, however, will be overridden if the category feature value of the prefix *en-* conflicts with the feature value of the head suffix. As a result, the relative ranking of the three constraints is as follows:

(33) PERCOLATE-HEAD 》 PERCOLATE-*en* 》 PERCOLATE-ROOT

9) According to Katamba (1993), this formal difference correlates with a semantic distinction. He proposes that there are two different prefixes which happen to be homophonous; the *en-* in (31a) has a causative meaning (e.g., *enable* is to 'make able'), while the *en-* in (31b) can be paraphrased as 'put in or into' (e.g., *encage* is to 'put in a cage). Discussion of this is beyond the scope of this paper. For details, see Katamba (1993).

Tableaux (34) and (35), for example, show how the constraint ranking above works to produce the correct output *enlarge*$_V$ and *encage*$_V$ from their input {*large*$_A$, *en*$_V$-} and {*cage*$_N$, *en*$_V$-}, respectively. In both cases, though having a violation of the constraint PERCOLATE-ROOT, the first candidates are chosen as optimal, as the other alternatives fatally violate the higher-ranked constraint PERCOLATE-*en*.

(34)

{large$_A$, en$_V$-}	PERCOL-HEAD	PERCOL-en	PERCOL-ROOT
☞ a. V / \ en$_V$ large$_A$			*
b. A / \ en$_V$ large$_A$		*!	

(35)

{cage$_N$, en$_V$-}	PERCOL-HEAD	PERCOL-en	PERCOL-ROOT
☞ a. V / \ en$_V$ cage$_N$			*
b. N / \ en$_V$ cage$_N$		*!	

As shown above, when a word is made up of the prefix *en-* and a root, it is the prefix whose category feature value is percolated up to the entire word. Then the question arises: what happens if a word has the structure '*en*-root-suffix', which would cause a conflict between PERCOLATE-HEAD and PERCOLATE-*en*? The ranking in (33) correctly predicts that in such cases, the suffix, which is the head of the word, determines the word-class of the output. Let us look at the following concrete example involving the prefix *en*$_V$-, the root *large*$_A$ and the suffix *-ment*$_N$.

(36)

{large$_A$, -ment$_N$, en$_V$-}	PERCOL-HEAD	PERCOL-*en*	PERCOL-ROOT
☞ a. N / | \ en$_V$ large$_A$ ment$_N$		*	*
b. A / | \ en$_V$ large$_A$ ment$_N$	*!	*	
c. V / | \ en$_V$ large$_A$ ment$_N$	*!		*

In (36a), neither the prefix *en-* nor the root *large* percolates its category feature value to the mother node, violating both PERCOLATE-*en* and PERCOLATE-ROOT. (36a), however, obeys the top-ranked constraint PERCOLATE-HEAD, since the category feature of the head suffix *-ment* is percolated. As a result, it is selected as optimal because the other alternatives violate the high-ranked PERCOLATE-HEAD.

Another prefix which changes the word-class of a base is *post-* (Katamba 1993). If the prefix *post-* is attached to a noun base, an adjective with meaning 'after' is formed (e.g., *war* vs. *post-war*). Prefixes such as *pro-* and *anti-* also cause category-change: *woman*$_N$, *pro-woman*$_A$; *monopoly*$_N$, *anti-monopoly*$_A$ (Strauss 1982). The present analysis can account for the feature percolation of the prefixes *post-*, *pro-* and *anti-* by ranking the relevant constraints PERCOLATE-*post*, PERCOLATE-*pro* and PERCOLATE-*anti* below PERCOLATE-HEAD but over PERCOLATE-ROOT in the constraint hierarchy.

5. Conclusion and Discussions

To summarize, I have shown that a constraint-based approach can throw light on several aspects of word-formation in English. In particular: (i) the ordering between class 1 and 2 affixes in

multiply-affixed words, (ii) the bracketing paradoxes, (iii) the ordering of derivational affixes with respect to inflectional affixes, (iv) the relationship of affixes belonging to the same class in a word, and (v) the determination of word category. It has been claimed that key among theoretical notions that enable the theory to perform these tasks are alignment, headedness and percolation. I have shown that, given a proper ranking of the relevant constraints, both the ordering of affixes and the determination of word categories can be satisfactorily accounted for. Specifically, regarding the ordering of affixes, I have argued for a constraint hierarchy which ranks ALIGNCLASS1 constraints over ALIGNCLASS2 constraints, and ALIGNDERSUF over ALIGNINFSUF. I have also claimed that once prefixation is assumed to be independent of suffixation, the bracketing paradoxes can be given a straightforward account by using some independently-motivated constraints. In addition, considering cases where affixes of the same class occur in a word, I have argued that the unviolable SUBCAT constraints come into force. Finally, I have also claimed that the headedness of affixes play a crucial role in determining the category of output words, arguing for the ranking PERCOLATE-HEAD 》 PERCOLATE-*en* 》 PERCOLATE-ROOT.

As discussed above, a constraint-based approach can provide a satisfactory account of several aspects related to affixation processes in English, particularly shedding light on the problems which could not be properly accounted for in a rule-based approach. Several unresolved problems remain, however. One is that although normally the constraint ranking of ALIGNCLASS1SUF ≫ ALIGNCLASS2SUF reflects the order of suffixes, with class 1 suffixes closer to the root than class 2 suffixes, there are some exceptions to this generalization. Examining the combinations of 43 English suffixes, Fabb (1988) argues that only four of those pairs that actually occur violate the AOG and those are *ment*$_2$-*al*$_1$, *ist*$_2$-*ic*$_1$, *ize*$_2$-*ation*$_1$ and *able*$_2$-*ity*$_1$. These cases seem to be true exceptions to the generalization that class 1 suffixes appear closer to the root than class 2 suffixes.

Another problem which has not been considered in this paper is how to block **ingrammaticality* in favor of *ungrammaticality*. Considering

that, unlike *ungrammaticality*, **ingrammaticality* would not cause the so-called bracketing paradox problems, it should be more harmonic than the actually occurring word *ungrammaticality*; however, this is not the case. As discussed above, the acceptability of *ungrammaticality* can be given a satisfactory account under the analysis argued for in this paper, but **ingrammaticality* remains unresolved. The obstinate problems mentioned above may be resolvable by future research.

Nevertheless, in spite of its defects, the analysis adopted in this paper is more satisfying than previous analyses and offers us a useful way of dealing with many of the major dimensions of word-formation in English.

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