A Categorial Analysis of
Bracketing Paradoxes in English*

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In this paper I present a formal account of "bracketing paradoxes" in morphology under a categorial framework. In this kind of system, Category Raising (CR) plays an important role in removing the "mismatches" between phonology and semantics. However, no previous approach was successful in properly restricting the application of CR. So, I propose two constraints for this purpose: a formal restriction and a lexical restriction. The former says that CR applies only when the arrangement of the morphemes in a word fits with a specified format. The latter, which is imposed by the lexicon, is an auxiliary constraint to the first restriction. We will see that this system can also provide a good account of bracketing paradoxes in compounds.

I. Introduction

The main topic of this paper is providing a proper analysis of "bracketing paradoxes" in morphology. There has been a lot of literature dealing with this problem (see references below). But previous approaches do not seem to be very successful in providing explicit mechanisms for analysis and in the implementation of relevant generalizations concerning the data. In this paper, I am going to provide a categorial system, which uses the mechanism of Category Raising in a crucial way. Also the relevant generalizations will be implemented into the system with reference to the function–argument structure of the word concerned.

In section II, we will examine two previous approaches to the bracketing paradox problem, which use special operations. But we also have some counter–examples to both of these approaches. In section III, we will provide a categorial approach, which elaborates upon Kang's (1988a, 1988b) approach. In this system, we do not use the concept of head. But head plays an improtant role in other approaches. Hence, in section IV, we will consider the relation between functor and head. Finally, in section V, we will see how the system developed in section III can be used in accounting for bracketing paradoxes in compounds.

II. Bracketing Paradoxes and Special Operations

As is well known, the following set of words shows bracketing paradoxes in the sense that they require two different bracketings, one for semantics and one for phonology (cf. Pesetsky 1985):

(1) a. un–happy–er ([[un–happy]–er] and [un–[happy–er]])
    b. un–grammatical–ity ([[un–grammatical]–ity]
       and [un–[grammatical–ity]])

The meaning of (1a), which is 'more unhappy' rather than 'not happier', requires the first bracketing in the parentheses. But the phonological fact that the comparative affix *–er* attaches to monosyllabic adjectives and a limited class of disyllabic adjectives requires the second bracketing. Likewise, in (1b), the meaning of the whole word and the behavior of prefix *un–* force us to use the first bracketing. But the Level Ordering Hypothesis of Lexical Phonology makes us posit the second bracketing because *–ity* is a Level I affix and *un–* is a Level II affix.

There are many different approaches proposed to handle the problem. In this section we will examine Hoeksema's (1985) "head–affixation" approach and Hammond's (1989) "peripheral–affixation" approach. Hoeksema (1985), under the traditional definition of the notion of head as follows (p. 57),

(2) In a construction consisting of a functor F and an argument A, the head constituent is F, unless it is endotypic (i.e. F is of the form X/X or X\X), in which case A is the head.

proposes head–affixation (a type of head operation) (p. 50):

(3) F is a head operation iff F(Y)=Z, and W=XY (where Y is the head of W) together imply that F(W)=X+F(Y)=X+Z.

Head–affixation can account for, among others, such bracketing paradoxes as in (1), under the assumption that *unhappier* and *ungrammaticality* are derived respectively from *unhappy* and *ungrammatical*, and under the assumption that the *–er* attachment and the *–ity* attachment are sensitive to the heads of these base constructs (i.e. *happy* and *grammatical*, respectively). That is, these attachments are assumed to be instances of head–affixation.

Hammond (1989), noting some counter–examples to head–affixation, argues that it should be replaced with peripheral–affixation. One type of counter–example is based on the prefix *be–* (a prefixal head), which can be attached to verbs, nouns, or adjectives, but the resulting category is always a transitive verb:

(4) be–speak, be–cloud, be–calm

He convincingly argues (pp. 6–7) that *be–* is the head of the whole word even when the stem is a verb. So, we cannot account for the irregular past tense form of *bespeak* (i.e. *bespoke*) under a head operation. There might be a solution to this problem, however. Under the assumption that each affix is specified for being subject to head–affixation or normal affixation, one might propose that the past tense formation is an instance of head–affixation. But this solution would not work here because there are cases (e.g. under*stood*, for*gave*, etc.) in which it should be treated as a head operation under Hoeksema's (1985) system.

The other type of counter–example to head–affixation is based on the combination of suffixes *–oid* (a suffixal nonhead) and *–al* (Hammond 1989: 10):

(5) sphere–oid–al, cube–oid–al, disc–oid–al

The attachment of *–al* is sensitive to the immediately preceding affix *–oid*. Notice that the suffix *–al* can only be attached to some specified morphemes.[1] But this fact cannot be captured under the head–affixation approach because *–oid* (N\N) is a non–head affix. This approach would pre-

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[1] The suffix *–al* is one of those suffixes which can be attached to (some) unsuffixed stems, or to stems with *–ion, –ment, –or,* or *–oid* (Hammond 1989: 8–10).

dict that the –al attachment has nothing to do with –oid.[2]

In the face of these counter–examples, Hammond (1989) refutes "the idea that heads can be the locus of affixations" (p. 5) and proposes that "affixation is possible to peripheral constituents, whether they are heads or not" (p. 7). Under this approach, the past tense formation in be–speak and the –al attachment in (5) operate on the peripheral elements speak and –oid, respectively, rather than on the heads of their base constructs.

Both of the above–mentioned approaches seem to provide an account for the bracketing paradoxes in (1). However, they have (meta–)theoretical and empirical problems in other respects. Hoeksema (1985: 50) says that even though the result of a head operation is a noncompositional structure, the way the operation is defined makes it possible to interpret the structure in a compositional fashion. However, his point about compositionality does not seem to be very convincing. There are two different representations involved in the operation concerned: the input representation and the output representation. The semantics of those words in (1) can only be captured in reference to the input representation. The output representation would not be able to provide both the phonology and semantics of the word compositionally.[3] In addition, Hoeksema (1985: 50) says that the relation "derived from" can be defined in a straightforward way in his framework. But this kind of derivational approach is not always desirable (cf. Zwicky 1989; section III this paper). The same criticisms hold for the peripheral–affixation approach.

The two approaches assume a special operation to account for concatenation phenomena in morphology. We may need some special operations as well as concatenation in morphology, especially in inflectional morphology. However, the attachment of –er or –ity seems to be a case of simple concatenation. Within a given set of data, if we can account for all the relevant

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[2] We might adopt the tactic of regarding the –al attachment as an instance of normal affixation. But it is not clear how we can capture the sensitivity relation under this assumption.

[3] This is a criticism against those operations which affect only formal aspects (or only semantic aspects) of a string concerned, as was pointed out to me by David Dowty (personal communication). Notice that Wrapping operations in some categorial approaches are the same in their nature as head/peripheral operations. If we can find independent motivations for these operations, the employment of them would not be very problematic in itself.

phenomena without a special operation, this system would be better than those which must adopt such an operation.

Most importantly, neither of the two approaches can handle such examples where affixation is sensitive to the heads of the base constructs but the heads are separated from the attaching affixes. Let us examine the following data, where suffixes are attached to those words which contain exotypic prefixes:

(6) a. en–danger–ed, en–code–ing,
        en–dear–ment, en–large–ment, en–title–ment
    b. be–friend–ed, be–witch–ed,
        be–friend–ing, be–witch–ing, be–little–ing,
        be–little–ment, be–dazzle–ment

In (6a) the attachment of the suffix –ed, –ing or –ment is sensitive to the category of the prefix en–. The head–affixation approach would wrongly predict that these suffixes come in between en– and the stem of the word (if the operation is head–suffixation) in each case because en– is the head of the base concerned. The result of the operation would be *en–ed–danger, *en–ing–code, *en–ment–dear, etc. On the other hand, the peripheral–affixation approach cannot capture the fact that the attachment of these suffixes is sensitive to the prefix en–, not to the base (cf. the argument in (5)). Notice such ungrammatical expressions as *danger–ed, *friend–ing, *dear–ment, etc. These expressions show that the attachments of –ed, –ing and –ment are not sensitive to the peripheral elements. Hence, we can say that peripheral–affixation cannot handle the relevant data, either. The data in (6b) present the same kind of problem to these approaches.

Lastly, let us consider how the two approaches handle the bracketing paradoxes in *unhappier* and *ungrammaticality* (cf. (1)). The problem here is solved with reference to the fact that the attachment of –er or –ity is an instance of a special operation. In a sense, the "special behavior" of these suffixes, which is represented as a special mode of combination, is assumed to be related to the paradoxical characteristics of the words. This implies that the bracketing paradox is caused by the suffixes –er and –ity. However, as we can see in section III, the paradox has nothing to do with these suffixes. On the contrary, it is triggered by the prefix un– in these words. This shows that the analyses provided by the two approaches are not correct. Based on

the above arguments, we can conclude that affixation cannot be accounted
for either by head-affixation or by peripheral-affixation, at least in English.

III. Function-argument Structure and Category Raising

. To account for affixation in those examples in section II and others, I
will provide a categorial approach, under which the order of morpheme
combination in a complex word is automatically determined by the
categorial specifications of the morphemes in the word. We will not need to
assume a special (head/peripheral) operation for affixation. Kang (1988a,
1988b) proposes such an approach, independently of the problems of the
previously-observed approaches. His system deals with a general issue of
"functional inheritance", which refers to those cases where the relationship
between functors and arguments is postponed in linguistic constructions.
He employs a Category Raising mechanism to handle bracketing paradoxes
in morphology. This mechanism in connection with Functional Composition
rules provides a powerful categorial system.

We will use the following rules and notational systems in this paper, fol-
lowing Steedman (1987):

(7) Functional Application (FA)
    a. X/Y : f Y : y ⇒ X : f(y)
    b. Y : y $X\backslash Y$: f ⇒ X : f(y)

(8) Functional Composition (FC)[4]
    a. X/Y : f Y/Z : g ⇒ X/Z : $\lambda x[f(g(x))]$
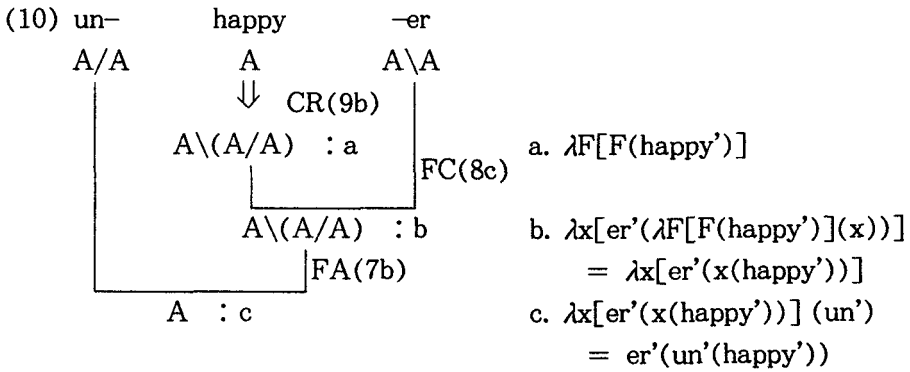
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[4] If we allow all of the four FC rules, we will face the problem of overgen-
eration, as was pointed out by Mark Steedman (personal communication). But we
need the disharmonic rules ((b) and (d)) to analyze those cases where one of the
morphemes in a word passes on its subcategorization requirement to the whole
word as in *willing-ness to go* ($A'/VP - N'\backslash A'$ VP) and *rebel-ion* (*against NP*).
There would be three possible ways of handling the problem here. First, we can
say that the subcategorization relation between a word and its derivative cannot
or, at least, need not be captured in morphology because there are many deriva-
tive words which do not have the same subcategorization requirement as their
bases. In this case, we need not use the disharmonic FC rules. Second, we can
restrict the use of disharmonic FC rules in such a way that they can be used only
when subcategorization requirements are involved in the analysis of a word.
Third, we can assign special categories for the morphemes involved in the inheri-
tance of subcategorization requirements (a suggestion made by Mark Steedman):
e.g. *willing-ness to go* ($A'/VP-(N'/VP)\backslash(A'/VP)$ VP). But we need to assign
multiple categories to *-ness* (cf. *fond-ness of dogs*) under this approach.

b. X/Y : f   Y\Z : g $\Rightarrow$ X\Z : λx[f(g(x))]

c. Y\Z : g   X\Y : f $\Rightarrow$ X\Z : λx[f(g(x))]

d. Y/Z : g   X\Y : f $\Rightarrow$ X/Z : λx[f(g(x))]

(9) Category Raising (CR)

    a. X : f $\Rightarrow$ Y/(Y\X) : λFF(f)

    b. X : f $\Rightarrow$ Y\(Y/X) : λFF(f)

Under the present framework, we can provide a suitable analysis for the bracketing paradox examples. Let us look at the case of *unhappier* (Kang 1988b: 32):

(10) un–   happy   –er

    A/A   A   A\A

            $\Downarrow$ CR(9b)

        A\(A/A) : a   a. λF[F(happy')]

                FC(8c)

          A\(A/A) : b   b. λx[er'(λF[F(happy')](x))]

            FA(7b)   = λx[er'(x(happy'))]

       A : c   c. λx[er'(x(happy'))] (un')

                      = er'(un'(happy'))

We can account for the correct formal properties (the fact that *happy* combines with *–er* first) and semantics (er'(un'(happy'))) without violating the principle of compositionality due to the role of the FC rule. Therefore, there is no longer a paradox. We can give the same analysis for *ungrammaticality*.

The sensitivity of *–al* and *–ment* attachments to *–oid* and *en–*, respectively, in the following examples (cf. (5–6)), which are problematic for head– and peripheral–affixations, can be captured by way of the function–argument (F–A) structures of the words:

(11) a. sphere   –oid   –al   b. en–   dear–   ment

       N   N\N   A\N   V/A   A   N\V

            N   V

              A   N
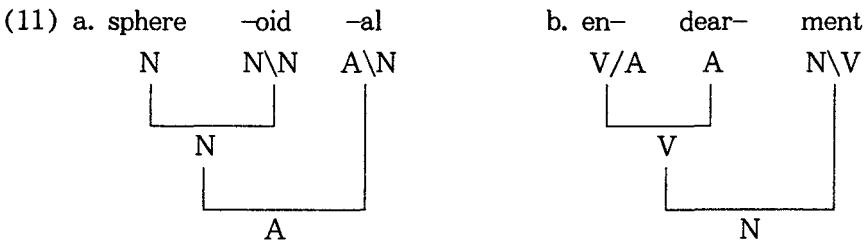
The fact that –*oid* is the functor in *spheroid* and *en*– is the functor in *endear* naturally accounts for the sensitivity relations and the correct bracketings between morphemes. Thus, we need not employ any special operations like head–affixation or peripheral–affixiation for concatenation in morphology.

But the system here is too poweful. There are some cases of overgeneration. For example, the present system licenses **analyze–ity–able* as well as *analyze–able–ity*. To restrict the power of the system, Kang (1988b: 54) allows only a specific kind of CR:

(12) Category Raising in (English) Morphology
$$X \Rightarrow X\backslash(X/X) \quad \text{or} \quad X \Rightarrow X/(X\backslash X)$$

The basic idea here is that only the argument of a modifier functor can undergo CR.

I agree with Kang's (1988a, 1988b) basic ideas that we need CR and FC in morphology and the application of CR should be limited in some way. But there are some important issues that are simply assumed or neglected in his analysis. For some of these issues I have ideas different from those implemented in his system. Let us consider these issues one by one.

Usually it is assumed that such words as *unhappier* and *ungrammaticality* are derived from *unhappy* and *ungrammatical*, respectively, at least in the tradition of "derivational" morphology. These analyses are motivated by the fact the *un*– is a derivational affix and –*er* is an inflectional affix in *unhappier*, and by the behaviors of the *un*– attachment and the –*ity* attachment in *ungrammaticality*. But, as we can see in (10), all the morphemes in a word are assumed to be on an equal status at the beginning of the analysis in Kang's approach. In other words, the word does not have a predetermined bracketing in it.

There have been arguments in the literature which demonstrate the inadequacies of the derivational approach. We can regard morphological rules as describing what is predictable within the lexicon (rules as redundancy predictors) rather than as supplying what is predictable within it (rules as generators of the lexicon), under the assumption that the lexicon is something which is full and highly redundant (Zwicky 1989: secs. 3.1 and 3.7). Under this view, the difference between derivational morphemes and inflectional morphemes does not affect the analysis because when we analyze, e.g. *unhappier*, we simply take this word as is listed in the lexicon. The fact

that the attachment of *un–* in *ungrammaticality* is sensitive to *grammatical* rather than *grammaticality* as a whole is represented in the categorial specifications of the morphemes in the word. The F–A structure determined by these specifications plays an important role in capturing the fact that affixation is constrained by the characteristics of the two adjacent morphemes because only adjacent morphemes can combine in a F–A structure. An approach with the F–A structure does not refer to the "derivational history" when we analyze a complex word.[5]

Notice that we can get the desired analyses for dealing with bracketing paradoxes in *unhappier* and *ungrammaticality* only when the second morpheme and the third morpheme combine first, and when CR applies to the second morpheme (cf. (10)). But in Kang's approach, it is simply assumed that the former condition holds (i.e. the second and third morphemes combine first). That is, he assumes a specific F–A structure (i.e. [X/X–[X–Y\X]]) in analyzing these words.[6] Even though the categorial specifications of the morphemes in a word usually determine a unique F–A structure for the word, it is not always the case. Here in the examples of bracketing paradoxes, the first morpheme and the second morpheme can also be combined first, which results in another F–A structure [[X/X–X]–Y\X]. There is no reason why this F–A structure should be disregarded. However, this structure would not give the desired analyses for dealing with the given data. Therefore, we need an explicit mechanism, by way of which it

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[5] One might say that the F–A structure of a word represents the derivational history of the word. But what is represented by it does not necessarily fit with the derivational history of the word concerned. For example, we assume that *ungrammaticality* is derived from *ungrammatical* rather than from *grammaticality* due to the behavior of *un–*, which attaches to adjectives. But the F–A structure of this word is [un–[grammatical–ity]] rather than [[un–grammatical]–ity], as we can see in (15b). The F–A structure of a word is determined solely by the categorial specifications of the morphemes in the word and by some independent principles.

[6] In Kang's approach it is not specified exactly when a particular F–A structure should be assumed among possible F–A structures. The issue is whether selecting a particular F–A structure is necessary only for bracketing paradox cases or for all those words where there is more than one possible F–A structure. I do not think we can assume a particular F–A structure only for the bracketing paradox cases because we do not know beforehand whether they involve paradoxes or not, at least in his approach.

naturally follows that the second and third morphemes combine first.

As for the application of CR, Kang assumes that it applies optionally and that the unwanted meaning of the non–Category–Raised version is filtered out by the unacceptability of the meaning itself. For example, in *un–happy–er*, if we do not apply CR to *happy*, and combine *happy* and *–er* first, then we get the meaning un'(er'(happy')). This meaning is unacceptable because *un–* does not properly apply to a comparative adjectival property in terms of semantics (Kang 1988b: 33). This kind of semantic analysis seems to work for *un–happy–er* and some others.[7] But semantic constraints are not enough in accounting for all the non–occurring meanings of words caused by the optional application of CR. As we will see later in (26), *county geologist* does not have the meaning ist'(county'(geology')) "a scholar of county geology". But this fact cannot be ascribed to semantic facts. Here what seems to be relevant is that *county* is not an actual element allowed to be compounded with *geology* because *county geology* is not a word listed in the lexicon (cf. Spencer 1988; constraint (14)). Thus, we need to refer to the functor of the category to be Category–Raised and/or these two elements as a unit. Kang (1988b: 34) also says that CR should be limited to the case of "modifiers". But what is represented in his formulation on the restriction of CR, i.e. (12), does not capture this fact. In (12) a (argument) category undergoes CR without reference to its modifier (functor).

Summarizing the problems in Kang's (1988a, 1988b) approach, the environment for the application of CR is not restricted properly. And the order of morpheme combination (i.e. the F–A structure) is not determined purely by the categorial specifications of the morphemes concerned. An unmotivated assumption is involved in selecting the F–A structure. To solve these problems we need to formally implement the idea that the (obligatory) trigger of CR is the modifier functor of the argument to be Category–Raised. Based on these observations, I propose to restrict the application of CR as

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[7] We may be able to account for the non–ambiguity of *nonhappier* in the same spirit. This has the meaning of non'(er'(happy')) (Spencer 1988: 669). But when we apply CR to *happy*, we get a wrong meaning er'(non'(happy')). The unacceptability of this meaning may be attributed to the semantic fact that *–er* cannot be applied to the meaning non'(happy') "it is not the case that happy", and/ or that the meaning non'(happy') is not an actual word meaning because *nonhappy* is not a lexical item in English (cf. (14)).

follows:

(13) $\{X/X \;\; - \;\; X\} \;\; - \;\; Y\backslash X$ $Y/X \;\; - \;\; \{X \;\; - \;\; X\backslash X\}$

$\Downarrow$ $\Downarrow$

$X\backslash(X/X)$ $X/(X\backslash X)$

The (curly) bracketing here does not mean that the whole word is derived from the bracketed construct. It simply indicates one of the two possible analyses of the concerned strings according to the categories of their morphemes. Therefore, CR does not apply when $\{X-Y\backslash X\}$ or $\{Y/X-X\}$ is analyzed first. In this paper, we will focus only on the first format, which involves pre-modifiers and suffixes, because the basic principles behind these two formats are the same.[8] With this mechanism we have opened the possibilities of referring to the modifier X/X and other constructs involved (i.e. [X/X-X] and [X-Y\X]). As we will see later, we need to refer to these constructs in accounting for the examples of bracketing paradoxes.

Format (13) says that CR obligatorily applies in a specific environment.[9] The category X/X implements the idea that only modifiers trigger CR, and Y\X indicates that CR is effective only when all the three morphemes are involved. Hence, CR does not apply to *un-happy* even though it does not affect the meaning. When we consider psychological processes involved in the interpretation of this word, it seems to be more reasonable to assume that

[8] I am not sure whether or not we need the second format in English. We would need this format only if there are cases of bracketing paradoxes which involve prefixes and post-modifiers. Such examples as *pre-attorney-general (period)* (N/N −N−N\N) might be relevant.

[9] The constraint (13) gives a natural account for the unambiguity of *mis-re-attach* (V/V−V/V−V). It has only the reading of mis'(re'(attach')) (Pesetsky 1985: 228−229). This is due to the fact that *attach* does not undergo CR in our approach. But according to Kang's (1988b) analysis with (12), it is ambiguous between mis'(re'(attach')) and re(mis'(attach')) because CR on *attach* is optional (pp. 57~58). To prevent the second meaning, Kang invokes a principle which says that "we should apply FA in case both FC and FA are possible". Therefore, we should apply FA when we combine the Category-Raised *attach* and *re-*, which will give the first meaning. But this solution does not seem to be desirable. First, the effect of CR is vacuous. If possible, it would be better to restrict the application itself properly rather than to restrict the result of the application. Vacuous application does not seem to have any psychological reality. Second, he invokes a principle to prevent overgeneration caused by unmotivated CR, leaving aside the issue of the validity of the principle.

CR does not apply at all rather than that it applies vacuously.

However, notice that the format in (13) is not a sufficient condition for triggering CR. Not all the cases of $[\{X/X–X\}–Y\backslash X]$ trigger CR on X. If we apply CR in *non–happy–er* and *county–geology–ist*, we would get incorrect meanings er'(non'(happy')) (cf. footnote 7) and ist'(county'(geology')). But we cannot say that *non–* itself has the characteristics of preventing CR because it triggers CR in *non–fiction–al* ('of nonfiction' or al'(non'(fiction'))) (cf. (15d)). And we have no a priori (semantic) reason that ist' (county'(geology')) cannot be a meaning of *county geologist*. To solve this problem I propose the following auxiliary constraint:

(14) The (complex) morpheme $\{X/X–X\}$ in (13) should exist in the lexicon as a separate lexical item.
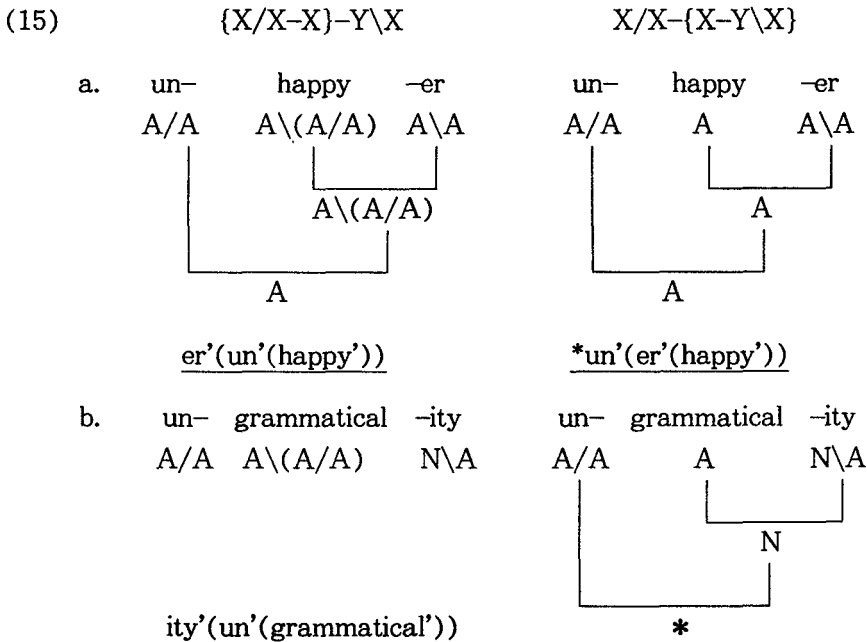
This constraint is an extended version of Spencer's (1988: 675) "Lexicalization Requirement", which says that "paradoxes can only be formed from members of the permanent lexicon". His original version was posited for the account of "personal noun" paradoxes as we can see in *transformational grammarian, atomic scientist*, etc. This kind of constraint cannot be implemented with Kang's format (12).

Constraint (14) can be regarded as a filter imposed by the lexicon to check the validity of CR triggered by (13). According to this constraint, we can say that *happy* in *non–happy–er* and *geology* in *county–geology–ist* do not undergo CR because *nonhappy* and *county geology* are not existing words in English.

Thus far, we have posited two constraints for the application of CR: a formal restriction (13) and a lexical restriction (14). Now let us consider how we can ensure that the Category–Raised element $(X\backslash(X/X))$ in format (13) combines with the third element $(Y\backslash X)$ first rather than with the first element (X/X). The account here is based on the obligatoriness of the CR. For example, *happy* in *un–happy–er* obligatorily undergoes CR as far as $\{un–happy\}–er$ is concerned because it meets all the conditions. Then, the categorial specification of this word becomes $[A/A–A\backslash(A/A)–A\backslash A]$. Still *happy* could combine with either of the two elements if nothing forces us to choose one analysis over the other. However, the fact that *happy* and *–er* combine first follows from a general principle here. If *un–* and *happy* combine first, there would be no effect of CR. When a special mechanism is in-

voked in the analysis of a linguistic expression, it should have some effect on the analysis. If the mechanism does not have any influence, it would not be invoked from the beginning. Due to this independently motivated principle, the Category–Raised *happy* combines only with *–er* with a FC rule. Here we can notice that the behavior of the Category–Raised element $(X\backslash(X/X))$ is also restricted in its behavior. It can only be Function–Composed with $Y\backslash X$.[10]

We have restricted the behavior of CR with reference to its triggering environment. We have also restricted the behavior of the category which has undergone CR with reference to a general principle. Only the argument of a X/X functor undergoes CR and then the raised category feeds the FC rules. With these restrictions, we can solve the problems which were raised in the framework of Kang (1988a, 1988b). Let us examine the following analyses (refer to (13) for the { } bracketing):
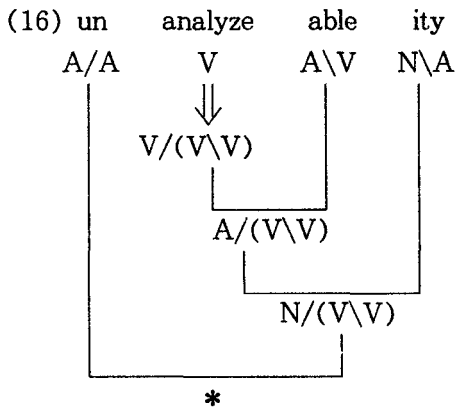
(15) $\{X/X–X\}–Y\backslash X$ $X/X–\{X–Y\backslash X\}$

a.
un–	happy	–er		un–	happy	–er
A/A	A\(A/A)	A\A		A/A	A	A\A

$$A\backslash(A/A)$$

$$A$$

er'(un'(happy'))   *un'(er'(happy'))

b.
un–	grammatical	–ity		un–	grammatical	–ity
A/A	A\(A/A)	N\A		A/A	A	N\A

$$N$$

ity'(un'(grammatical'))   *

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[10] We can implement the idea that a specific category should be Function–Composed by using a special category for the result of CR, e.g. $X^*\backslash(X/X)$ and by stipulating that this special category can only be the input to FC (cf. Jacobson 1990). However, this kind of stipulation is not necessary under our approach because the fact that the Category–Raised element can only be Function–Composed follows from a general principle.

c.   non–   happy   –er[11]   non–   happy   –er
     A/A *A\(A/A) A\A   A/A   A   A\A
                                          non'(er'(happy'))

d.   non–   fiction   –al   non–   fiction   · –al
     N/N   N\(N/N)   A\N   N/N   N   A\N

        al'(non'(fiction'))   non'(al'(fiction'))

All the anayses considered in the left–hand column meet the requirements imposed by condition (13). But *non–happy–er* in (15c) does not undergo CR because it is constrained by condition (14). In (15a), we can provide both of the two possible analyses. But the meaning derived from the second analysis is unacceptable, as we have seen above, due to the semantic characteristics of *un–*. In (b), the second analysis is ruled out by the impossible F–A structure. In (d), both of the analyses give legitimate results. Therefore, the word is ambiguous between 'of nonfiction' and 'not fictional'.

From a processing point of view also, our approach seems to be more

(16) un   analyze   able   ity
     A/A   V   A\V   N\A
               ⇓⇓
          V/(V\V)

          A/(V\V)

            N/(V\V)

              *

---

[11] Even though *happy* in *non–happy–er* does not undergo CR, it may still be analyzed as [{A/A–A}–A\A], giving the meaning of er'(non'(happy)). This meaning can be ruled out by semantic reasons as is indicated in footnote 7. But we need to enforce a more general restriction to prevent this analysis because we cannot provide such a semantic account for the ist'(county'(geology')) meaning for *county geologist*. We need to say that constraint (14) prevents all the possible analyses of [{X/X–X}–Y\X] when the complex morpheme [X/X–X] is not an actual lexical item. The difference between er'(non'(happy')) and ist'(county'(geology')) is that the former is an impossible meaning while the latter is a possible but not actually existing meaning.

realistic than the previous approach. If we simply assume that any category can undergo CR as is stated in (12), we can only know whether the raising is legitimate or not at later stages of the analysis. For example, in the case of (16), we can only realize that the CR is illegal at the last stage of the analysis (under the assumption that disharmonic FCs are allowed in morphology). Realizing that CR was not applied properly, we must go back to the starting point because there are other possibilities of analysis. This poorly restricted CR would double the burden of analysis for every word in the lexicon. This kind of "reanalysis" seems to be unrealistic. But under our approach we know that CR is not allowed in this case from the beginning.

IV. Head(ness) and Functor

In our approach in section III we did not use the concept of head. The F–A structure is all that is necessary. But Hoeksema's (1985) approach uses head in a crucial way. And head plays an important role in many theories. In this respect, we will consider how the phenomena related to head are realized in our framework, and consider the relation between head and functor. In Zwicky (1985), it has been shown that head does not represent a homogeneous phenomenon in syntax and morphology. According to Zwicky, the head in morphology plays a double role (p. 2): the morphosyntactic locus (the morphological constituent that bears inflectional markings) and the morphological determinant (the constituent that determines the category of the construct).

We might be able to define the intuitive notion of head under this system.[12] But the real issue is whether we need such a notion in describing word structures or not. Here we will see that we need not employ head as a primitive notion. All the head–like notions are derivable from the F–A structure (or from the categorial specifications of the morphemes in a word). As for the "head as the morphosyntactic locus" we will follow Zwicky (1985: 22), who says that "morphological principles locating inflectional morphemes seem always to refer to margins, never to morphological constituents that

---

[12] We can define head as the functor of a construct regardless of whether it is endotypic or exotypic. Even in those cases where endotypic functors are involved as in *un–happy*, the functor (*un–*) seems to be more "head–like" than the argument (*happy*) as will be argued in this section.

would constitute heads on any criterion other than this one". In other words, we can say that morphosyntactic locus has nothing to do with head.

Let us see how the "head as the morphological determinant" can be defined based on the F–A structure of a word. When FA rules are involved in the combination of morphemes, the functor is always the category determinant:

(17) a. happy–ness,   realize–ation,   en– danger
        A   N\A   V   N\V   V/N   N

     b. doctor–ate,   friend–ship,   peron–age
        N   N\N   N   N\N   N   N\N

     c. un– happy,   il– legal,   un– lock,   re– run
        A/A   A   A/A   A   V/V   V   V/V   V

When the affixes concerned are exotypic as in (a), there has been no dispute on its status as the "head as the category determinant". But when endotypic functors are involved as in (b–c), one might say that the category of the word is determined by the argument rather than by the functor.
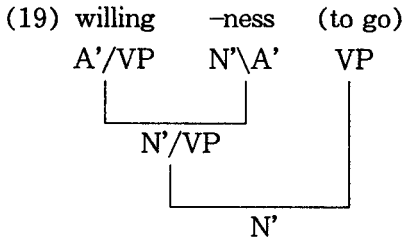
However, it seems to be reasonable to assume that endotypic functors are also the category determinant because an affix (regardless of whether it is a prefix or a suffix) can occur only in some specified construct(s) but stems can occur in several constructs. For example, affixes *un–* and *–ship* can occur only in adjective constructs and noun constructs, respectively, as we can see in *unhappy, unreal*, etc, and *friendship, internship*, etc. However, stems *happy* and *friend* can also occur in other constructs as in *happiness, happily, befriend, friendly*, etc. In this respect, we can argue that the category determinant of an endocentric construct is not its argument but its functor. The point here is more evident in the following cases:

(18) a. blue–ish (cf. hell–ish, tickle–ish)
     b. parent–hood (cf. lively–hood, likely–hood)
     c. king–dom (cf. free–dom)

The affixes here can be attached to more than one category of stems. They are endotypic when their bases are of the same category as the resulting category. But they are exotypic in other cases. The explanation would be very complex if we do not assume that the functor is the category determinant.
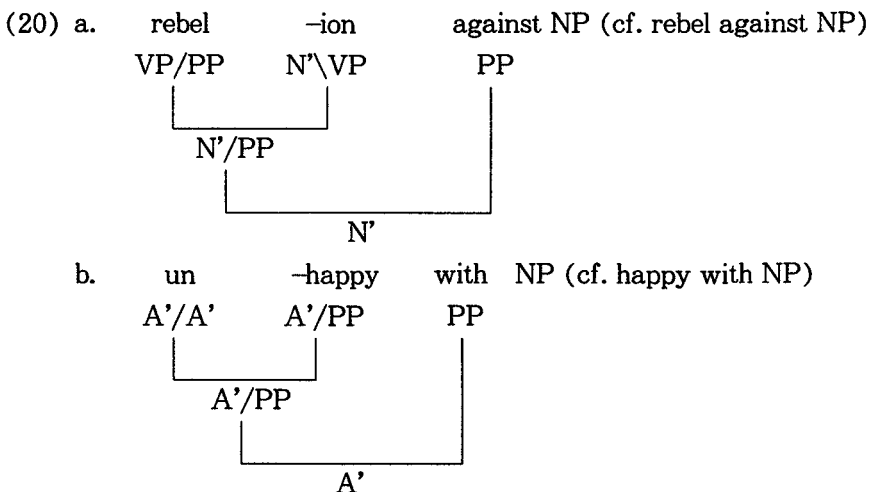
Then, let us consider how the category of a composite construct is deter-
mined when the two morphemes concerned are both functors. Here FC
rules are responsible for the combination of source morphemes and
responsible for the determination of the resulting category. Let us consider
the following example:

(19) willing   −ness   (to go)
        A'/VP   N'\A'   VP
          └─────────┘   │
             N'/VP   │
                └────────────────┘
                       N'

As we can see here, the category of the resulting construct is correctly de-
termined by the FC rules (cf. (8)).

Summarizing, the category determinant of a complex construct is (the
range of) the functor or the principal functor (the category which contains
X in (8)): the functor when FA rules are involved and the principal
functor when FC rules are involved.

We can think of another head-like notion with reference to "property in-
heritance" (Zwicky 1987: 273–4). Here we will focus on those cases where
the subcategorization requirement of a derivative is inherited from one of
its components ("complement inheritance"):

(20) a.   rebel   −ion   against NP (cf. rebel against NP)
           VP/PP   N'\VP   PP
             └──────────┘   │
                N'/PP   │
                   └──────────────────┘
                          N'
     b.   un   −happy   with NP (cf. happy with NP)
           A'/A'   A'/PP   PP
             └──────────┘   │
                A'/PP   │
                   └───────────────┘
                         A'

As we can see in (19) and (20), FC rules enable us to capture the fact

that the derivative retains the subcategorization requirement of one of its head-like elements.

In (20a) the PP in VP/PP of *rebel* has nothing to do with the determination of the category of the resulting word. Thus, *rebel* is not the head of *rebellion* in the sense of category determinant. But it determines the subcategorization requirement of the resulting word. Therefore, it is the head of *rebellion* in the sense of property inheritor. This inheritor can be defined as the subsidiary functor in our framework. The same is true with the example (20b).

V. Bracketing Paradoxes and Compounds

We can see bracketing paradoxes also in compounds of the form in (21a) when they show the "external attachment" pattern of (21b) (Zwicky 1987:266):

(21) a. $[W_1 + W_2 + S \text{ (uffix)}]$
     b. $W = W_{1+2} (= W_1 + W_2) + \text{Suffix}$
     c. $W = W_1 + W_{2+s} (= W_2 + \text{Suffix})$

But when the compounds have the "internal attachment" pattern in (21c), they do not show bracketing paradoxes. Because the problem of bracketing paradoxes is handled with reference to CR in our framework, we can infer that only the external attachment pattern invokes CR. In section III, we have seen that CR requires two conditions: a formal condition of $[\{X/X–X\}–Y\backslash X]$ (13), and a lexical condition that the unit $[X/X–X]$ must exist as a separate word in the lexicon (14).

First, let us consider how we can analyze examples of A(djective)+N (oun) compounds of the following:

(22) a. transformational   grammar   ian[13]
            {N/N   N}   N\N
                              ⇓
                            N\(N/N)

                        N\(N/N)

                            N

      b. Chinese history   ian
         {N/N   N}   N\N

From a semantic point of view, the affix -*ian* is attached to the whole compound. But, from a phonological point of view, it is attached to the second element of the compounds.[14] As we can see in (22a), the bracketing paradox can be accounted for under the framework developed in section III.

I will argue that we can use the same mechanisms in dealing with bracketing paradoxes in N+N compounds:

(23) juncture grammar   ian
     N/N   N   N\N

One might say that it is arbitrary to assign category N/N to *juncture* here. But we have some evidence which shows that the first elements of compounds in (22) and (23) are of the same category (N/N), which is different from normal (modifying) As (i.e. N'/N) (Zwicky 1987: 270):

(24) a. *adequate and relational grammars
     b. relational and jucture grammars

From the example in (a) we can see that As in compounds do not cooccur with normal As as conjuncts of coordination. And I think they do not show the inflectional paradigm of normal As, either. But they can cooccur with Ns in the compounds as in (b). These facts show that the analyses in (22–23) are plausible.

We have assigned category N/N to the first elements of A+N and N+N compounds. This means that these elements have affixal status in compounds. But we have seen in footnote 14 and (24) that they can occur as conjuncts in coordination. Our usual assumption is that conjuncts consist of

---

[13] Here we need to explain why *transformational–grammar–ian* (N/N–{N – N\N}) is not a ·possible analysis, which gives the meaning of transformational' (ian'(grammar')). This may be a possible meaning of the word. But it does not actually occur in the lexicon as a meaning of the word just like the meaning of *county geology* does not.

[14] The syntactic properties also require the same bracketing as that for phonology, as is pointed out in Zwicky (1987: 274):

i) a. transformational and stratificational grammarians
    b. a generative syntactician or phonologist
ii) She's the Japanese historian, and she's the Chinese (one).

The second word in the compound and the affix function as a syntactic constituent in coordination and anaphora/ellipsis.

units equal to or larger than the level of a word. Thus, there seems to be a contradiction on the status of the first elements of A+N and N+N compounds. They behave like affixes in some cases but like "words" in other casses. However, the seemingly contradictory nature here is due to the special characteristics of (syntactic) compounds themselves. They are constituents of "rank W(ord)" that contain constituents of rank W (cf. Zwicky 1990):

(25) W_{MAX}

          W_{MIN} W_{MIN}
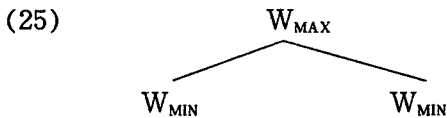
A W_{MAX} (compound) includes W_{MIN}'s. The status of W_{MIN} can be defined differently according to the requirements of the specific rules concerned.

As we have observed above, W_{MIN}'s are legitimate units for the operation of such syntactic rules as coordination and ellipsis. In this sense, they behave like words for the purpose of these rules. However, as different rules can have different requirements on their input, we can say that a unit of W_{MAX} behaves as a word for the purpose of CR application in morphology. In other words, the unit which is represented by format (13) is W_{MAX} rather than W_{MIN}. If the W_{MAX} behaves as a word for the application of CR, then it is not surprising that the W_{MIN} has the status of an affix. By resorting to the assumption that different rules can have different requirements for their application, we can account for the "contradictory" nature of the status of the first elements of A+N and N+N compounds. And we can still maintain the assumption that the smallest input units for coordination and ellipsis are (syntactic) words.[15]

There are some compounds which show only the internal attachment pattern of (21c) (Zwicky 1987: 266):

---

[15] The following examples might be problematic for the view here because the elements in (i) seem to be affixes rather than words:
  i) super–, proto–, meta–, inter–, intra–, pro–, hydro–, under–, over–,
     conter–, pre–, post–, etc.
  ii) super– and proto–men, under– and over–developed,
      hydro– and atomic electricity

But they can be conjucts in coordination as we can see in (ii). However, words containing them can better be regarded as compounds rather than simple words. Notice that all of the elements in (i) have their own stress.

(26) a. county geologist 'geologist for the county'
     b. house grammarian 'grammarian for the house'

These expressions do not involve CR because they do not show the external attachment pattern. This can be explained based on the second condition on the applicability of CR (14). They do not undergo CR because *county geology* and *house grammar* do not exist as independent words in the lexicon. As we have seen before, this kind of example constitutes one of the most important pieces of evidence for our condition (14). No semantic principles can account for the non–existence of *county geology* and *house grammar*.
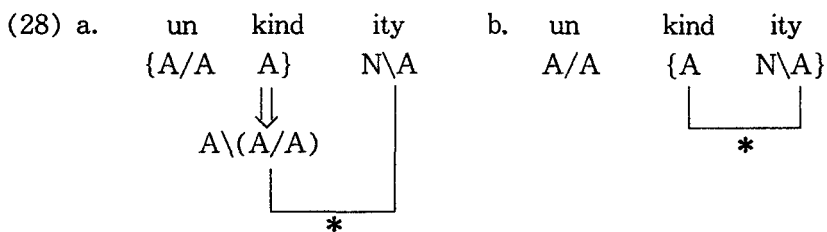
Notice that our auxiliary constraint on the applicability of CR (14) should be weakened somewhat when we take compounds into consideration. This weakening is implied in Spencer's (1988: 675) original definition of the Lexicalization Requirement: "the source expression (i.e. the [X/X–X] part) should be lexicalized or *perceived as such*":

(27) a. kind–hearted (cf. *kind–heart)
     b. on–looker (cf. *on–look)
     c. by–stander (cf. *by–stand)
     d. under–developed (cf. *under–develop)

These expressions contain non–existing expressions as their source. But we can perceive these non–existing source expressions as some kind of lexical item. Even though they do not exist as actual words in the lexicon, they play a role in getting at the meaning of the whole expressions. The whole expressions and their starred source expressions might not be related directly but they are related in some way. For example, *on–looker* seems to be related to VP *look on* even thought it is not related to *on–look*.
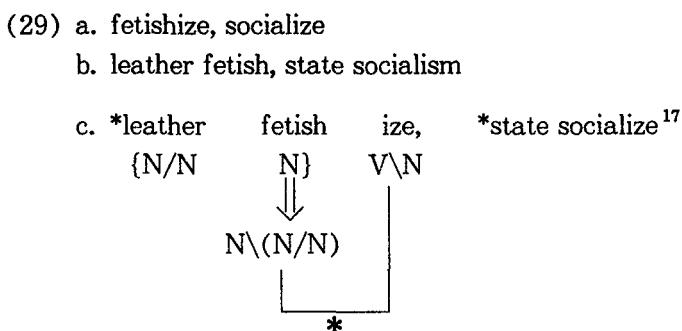
Then, let us consider how we can account for such expressions as *unkindity* (cf. *ungrammaticality*). Zwicky (1987: 273) accounts for this phenomenon as an example of property inheritance. *Kind* has the [+AS] ("Anglo–Saxon") value for the stratum feature. This value is inherited in *unkind* because the *un–* prefixation rule does not block property inheritance. Then, *unkindity* is ungrammatical just as *kindity* is ungrammatical because the rule deriving abstract Ns from As by suffixing –*ity* is constrained to apply only to [−AS] sources. Under our system, we can give an account for *unkindity* on the basis of Spencer's (1988: 675) "(Same) Lexical Source Requirement", a part (cf. (30)) of which says that "the head noun

bearing the affix itself (in personal compounds) must be a word".[16] This restriction was originally posited for the account of "personal noun" paradoxes. But I think it can be adopted here for our purposes:

(28) a.   un   kind   ity   b.   un   kind   ity
          {A/A   A}   N\A   A/A   {A   N\A}
                  ⇓   └──────┘
          A\(A/A)   │   *
                  └──────┘
                     *

In (a), even though A is Category–Raised to A\(A/A), the next step of FC is not allowed because it is an illegal combination according to the (Same) Lexical Source Requirement. This combination would give *kindity*, which does not exist in the lexicon. The point here illustrates that we need to refer to the [X–Y\X] part of [X/X–X–Y\X] in (13) to get a generalization. In (b), the first step of combination is blocked.

It is also observed in Zwicky (1987: 272) that "virtually all productive rules of primary morphology (rules of *–ity, –ian, –al, –ic(al)*, and *–th* attachments) can have the semantics of external combination. But affix *–ize* is a special one in the sense that it allows only the meaning of internal combination":

(29) a. fetishize, socialize
     b. leather fetish, state socialism

     c. *leather   fetish   ize,   *state socialize[17]
          {N/N   N}   V\N
                     ⇓
          N\(N/N)   │
                  └──────┘
                     *

---

[16] This condition should be weakened somewhat because we have words like *kind–hearted* (cf. **hearted*) and *unrulier* (cf. **rulier*).

[17] These words do not have any meaning because the other analysis is also impossible: *leather fetish ize.*

     N/N   {N   V\N}
          │   └──────┘
          │   V
          └──────┘
             *
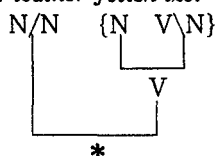
The ungrammaticality of the expessions in (c) is due to the special charac-teristics of *-ize* itself. We can implement this fact by saying that it has a feature which prevents it from being an input to FC rules.[18] We know that FC rules should be applied to get the external meaning. Notice the differ-ence between *unkindity* in (28) and those expressions in (29c). In the for-mer case, the non-existence of *kindity* blocks all the possible analyses. But, in the latter case, the characteristics of *-ize* itself blocks the analysis.

To account for the ungrammaticality of the following expressions, Spen-cer (1988: 675) assumes the "Same Lexical Source Requirement", another part (cf. (28)) of which says that "paradoxes may only be licensed by an instance of precisely the same lexical entry".

(30) *bad grammarian, *white elephantine

The first expression is ungrammatical because the meaning of *grammar* in *bad grammar* ('adherence to socially accepted speech norms') is different from that of *grammar* in *grammarian*. The second expression is ungrammati-cal when *white elephant* has the meaning of 'a usually big object not useful to its owner'.

However, the problem here does not seem to be particular to bracketing paradoxes:

(31) *bad and transformational grammars

This expression is ungrammatical (with the compound meanings) due to the same reason as that for the expressions in (30). In *bad grammarian*, *grammar* is a part of *bad grammar* and at the same time a part of *grammari-an*. In this sense, the role of *grammar* here is the same as that in (31). In both of these cases, *grammar* is the factor in the complex construct con-cerned. The factor is licensed only when the lexical item which is required by each of the two base constructs is the same. But it is not the case in both (30) and (31). Then we can say that Spencer's Same Lexical Source Requirement induced to account for data such as those in (30) is not ap-propriate because this requirement has no intrinsic relation with bracketing paradoxes. The ungrammaticality of the expressions in (30) and (31)

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[18] It would be very nice if we can find some semantic reason for the fact that *-ize* does not allow the meaning of external combination. Then it would not be necessary to posit a feature to prevent the application of FC rules.

comes under the same general principle, say "prohibition against a mixed factor".

In this section, we have seen that the same set of mechanisms which are used to account for bracketing paradoxes in words like *unhappier* and *ungrammaticality* can be used to handle bracketing paradoxes in compounds. First, we have observed A+N compounds and N+N compounds. While analyzing these words, we have argued that A in A+N compounds and the first N in N+N compounds have the same category. Then, we have provided analyses for some other sets of data, which have the same format as the afore–mentioned compounds but do not show bracketing paradoxes. We have shown that all these data can be handled under our approach.

VI. Conclusion

In this paper we have presented a categorial approach for the bracketing paradoxes in words including compounds. Without employing any special operations such as head–affixation or peripheral–affixation, our approach handles the relevant data on the basis of the F–A structure, which is regulated by FA rules, FC rules and CR. More importantly, we have provided a set of restrictions on the application of CR, which makes it possible to get a unique analysis of the words showing bracketing paradoxes based on the categorial specifications of the morphemes concerned. Without these restrictions, the mechanism would be too powerful.

We have seen that CR is applied in fairly restricted situations in morphology. This seems to be one of the differences between morphology and synax. In syntax, the application of CR is not so tightly restricted as in morphology (cf. Dowty 1988). This may be due to the fact that the order of morphemes in words is almost fixed but the order of words in phrases is not very fixed even though it is not completely free.

References

Dowty, David (1988) 'Type Raising, Functional Composition, and Non–constituent Conjunction,' *Categorial Grammars and Natural Language Structures,* ed. by Richard Oehrle et al., 153~197, D. Reidel Publishing Co.

Hammond, Michael (1989) 'Peripherality and Head Affixation in Morphology,' ms., University of Arizona.

Hoeksema, Jack (1986) *Categorial Morphology*, Garland Publishing, Inc.

Jacobson, Pauline (1990) 'Raising as Function Composition,' *Linguistics and Philosophy* 13, 423~75.

Kang, Beom-mo (1988a) 'Constraining Category Lifting in Categorial Morphology,' *ESCOL* '87, 164~175.

Kang, Beom-mo (1988b) 'Functional Inheritance, Anaphora, and Semantic Interpretation in a Generalized Categorial Grammar,' Ph.D. Dissertation, Brown University.

Pesetsky, David (1985) 'Morphology and Logical Form,' *Linguistic Inquiry* 16, 193~246.

Spencer, Andrew (1988) 'Bracketing Paradoxes and the English Lexicon,' *Language* 64, 663~682.

Steedman, Mark (1987) 'Combinatory Grammars and Parasitic Gaps,' *Natural Language and Linguistic Theory* 5, 403~439.

Zwicky, Arnold (1985) 'Heads,' *Journal of Linguistics* 21, 1~29.

Zwicky, Arnold (1987) *'Transformational Grammarians* and Their Ilk,' *MIT Working Papers in Linguistics* 9, 265~279.

Zwicky, Arnold (1989) 'Some Choices in the Theory of Morphology,' (to appear in) *Formal Grammar: Theory and Implementation*, ed. by S. Davis and R. Levine, University of British Columbia Press.

Zwicky, Arnold (1990) 'Syntactic Words and Morphological Words, Simple and Composite,' *Yearbook of Morphology* 3, 201~216.

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