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On Dvandva Compounds in Japanese

Masanobu Ueda

1. Introduction

There has been recognized a type of compound which is referred to as a "dvandva compound" (or a coordinate compound). Although this type of compound was originally identified in Sanscrit grammar, there are many instances of it in Japanese. Observe the following exmaples:

(1) a. kusa + ki ⟶ kusaki
'grass' 'trees' 'grass and trees'
b. yama + kawa ⟶ yamakawa
'mountains' 'rivers' 'mountains and rivers'

It has been pointed out in the previous literature that Japanese dvandva compounds such as (1) have peculiar phonological and morphological properties as well as semantic peculiarities.[1] Among the phonological peculiarities, included are the following two properties:

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1. See Otsu (1980), Kageyama (1982) for discussion.

(2) a. The inapplicability of *rendaku* (sequential voicing).
b. The occurrence of a typical phrasal accent pattern.

Let us review these two properties in turn.

First, *rendaku* (sequential voicing) can be roughly characterized as a voicing rule which applies to certain types of compounds and derivatives, and changes the initial consonants of their second members into [+voice]. Observe the following examples:

(3)	a.	shibu	+	kaki	⟶	shibugaki
		'astringent'		'persimmon'		'astringent persimmon'
	b.	hoshi	+	sora	⟶	hoshizora
		'star'		'sky'		'starry sky'
	c.	ami	+	to	⟶	amido
		'net'		'door'		'screendoor'

In the compounds of (3), the initial segments of the second members /k, s, t/ are changed into their voiced counterparts /g, z, d/ by this rule, respectively. Note that *rendaku* does not apply to dvandva compounds, as shown in (4):

(4)	a.	uri	+	kai	⟶	urikai
		'selling'		'buying'		'selling and buying'
	b.	yomi	+	kaki	⟶	yomikaki
		'reading'		'writing'		'reading and writing'
(5)	a.	shoodoo	+	kai	⟶	shoodoogai
		'impulse'		'buying'		'impulse buying'
	b.	tate	+	kaki	⟶	tategaki
		'vertical'		'writing'		'vertical writing'

Compare (4) with the righthand-headed compounds (5) to which *rendaku* applies. The contrast between (4) and (5) indicates that the failure

of the application of *rendaku* in (4) cannot be attributed to the lexical properties of the morphemes constituting the second members of the compounds, i.e., *kai* 'buying' and *kaki* 'writing', since *rendaku* applies to these morphemes in (5).

Second, as stated in (2b), dvandva compounds have a typical phrasal accent pattern, which can be characterized as the predominance of the leftmost accent in the domain. Observe the following examples of Postpositional Phrases (PP) (6)[2] and dvandva compounds (7) (We indicate the position of accent with *.):

(6)	a.	kokoro*	+	made*	⟶	kokoro* made
		'mind'		'to'		'to the mind'
	b.	miyako	+	made*	⟶	miyako made*
		'capital city'		'to'		'to the capital city'
(7)	a.	natsu*	+	fuyu*	⟶	natsu*fuyu
		'summer'		'winter'		'summer and winter'
	b.	uchi	+	soto*	⟶	uchi*soto
		'inside'		'outside'		'inside and outside'

These examples show that dvandva compounds exhibit exactly the same accent pattern of phrases, i.e., the predominance of the leftmost accent in the domain. Note that the rightmost accent is typically predominant in endocentric compounds, as shown in (8):

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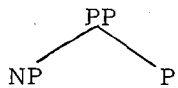
2. We assume that the sequence of NP + Postposition constitutes a Postpostional Phrase like:

(i)


and that Postpositional Phrases as well as words constitute the tonological domains, in which the rules of tone association apply.

(8) a. natsu + mikan ⟶ natsumikan
'summer' 'mandarin orange' 'a kind of orange'
b. makura + kabaa ⟶ makurakabaa
'pillow' 'cover' 'pillow case'

The compounds in (8) are righthand-headed, and the accents of their second members are predominant.

In this paper, we will attempt to argue that dvandva compounds are represented in a non-linear fashion in the lexicon, and show that the peculiar properties mentioned above naturally follow in our non-linear analysis of dvandva compounds. We will assume the framework of lexical phonology as conceived in Kiparsky (1982a, b) and that of autosegmental theory as conceived in Goldsmith (1976) or of its more extended version as conceived in McCarthy (1982) when necessary.

2. A Proposal

2.1. A Stacked Analysis of Dvandva Compounds

Essentially following Selkirk (1982), we assume that compounds and derivatives are generated by a set of context-free rewriting rules in the lexicon. It is further assumed that three category levels are distinguished in Japanese, i.e., affix, root, and word. Thus, a set of rewriting rules for Japanese compounds can be schematically represented as (9):

(9) a. word ⟶ word word
b. root ⟶ root root
c. word ⟶ root

(9a, b) represent that compounding occurs at the levels of both word

and root, and (9c) that the two levels are "connected." Finally, we assume that the Righthand Head Rule (RHR) (Williams, 1981) is operative in unmarked cases in Japanese.

With these assumptions as background, we propose the following schema for the rules generating dvandva compounds:

$$(10)\quad X^n \longrightarrow \begin{bmatrix} X_1^n \\ \vdots \\ X_n^n \end{bmatrix} \qquad \text{where } n = \text{word or root}$$

(10) represents that dvandva compounds are stacks of lexical items (words or roots) in underlying representations. Thus, dvandva compounds *oya-ko* 'parent and child' and *dan-zyo* 'man and woman' are, for example, generated by the rules like (11) and have underlying representetions like (12):[3]

$$(11)\quad \text{a.}\quad N \longrightarrow \begin{bmatrix} N \\ N \end{bmatrix}$$

$$\text{b.}\quad N^r \longrightarrow \begin{bmatrix} N^r \\ N^r \end{bmatrix} \qquad (N^r = \text{root})$$

3. Our proposal is along the lines of Williams' (1978) proposal. He argues that there is every reason for assuming that coordinate structures have labelled bracketings as defined in (i):

(i) Definition
The structure

$$\left[\begin{array}{l} [X_1]_{C_1} \\ \vdots \quad \text{and} \\ [X_n]_{C_n} \end{array}\right]_C$$

is a well formed labelled bracketing if $X_1, \ldots, X_n$ are.

In this sense, our proposal is simply an extension of Williams' analysis to the coordination in morphology.

(12) a. $\begin{bmatrix} [_N \text{ oya}] \\ [_N \text{ ko }] \end{bmatrix}$

b. $\begin{bmatrix} [_{N^r} \text{ dan}] \\ [_{N^r} \text{ zyo}] \end{bmatrix}$

Note that *oya-ko* is a word-level compound and *dan-zyo* a root-level one. We assume that these representations are linearized by the rule (13) before they are inserted in syntactic structures:[4]

(13) $\begin{bmatrix} X_1^n \\ \vdots \\ X_n^n \end{bmatrix} \longrightarrow [X_1^n \cdots\cdots X_n^n]$

One immediate advantage of our proposal is that the inapplicability of the Righthand Head Rule to dvandva compounds, which are often characterized as "double-headed," naturally follows as a consequence from the non-linear representation of dvandva compounds and the nature of the RHR, which defines the headedness crucially based on the left-to-right relation of the constituents.[5]

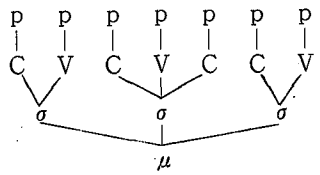
4. (13) is essentially the same as Williams' rule of linearization. We assume here that the elements in the schema are linearized in accordance with the numerical order of the integers subscripted to them. However, as Kageyama (1982) points out, the order of elements in dvandva compounds is not free. For example, *oya-ko* 'parent and child' cannot be * *ko-oya*. He suggests that the order of elements in dvandva compounds is "determined by a variety of linguistic, social, and cultural factors related to the notion 'priority': the element of a higher priority comes first." (Kageyama, 1982; 327) We tentatively assume that Kageyama's claim is basically correct, and that dvandva compounds are generated freely in the lexicon and later subject to some semantic or pragmatic condtion at LF or in some other cognitive system.
5. We tentatively assume that RHR apply cyclically. Only with this assumption, the inapplicability of RHR to dvandva compounds follow in

In the following sections, we will show that the exceptional behaviour of dvandva compounds with respect to accentuation and *rendaku* (sequential voicing) can be naturally accounted for under our stacked analysis of dvandva compounds. Before doing so, we will show that an observation on reduplication in Japanese provides a support for the stacked analysis of dvandva compounds.[6]

2.2. Reduplication

Marantz (1982) proposes an analysis of reduplication, in which he defines the process of reduplication as the process of affixing a C-V skeleton, a syllabic skeleton, or a morpheme to the stem under the assumption that a morpheme has a hierarchical structure like (14):

(14) phonemic melody
C–V skeleton
syllabic skeleton
morpheme symbol



such a way as stated in the text. This is so, because dvandva compounds are linearized at the end of cycles in our analysis, as we will discuss later. See Selkirk (1982) for a different approach to RHR.

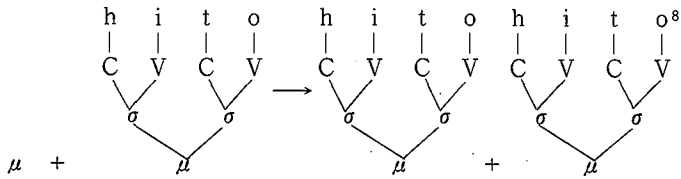
6. There are at least three other possible approaches to account for the peculiar properties of dvandva compounds: i) to assume that dvandva compounds are the compounds at the level of phrases (Otsu, 1980); ii) to adopt the level-ordering hypothesis and assume that dvandva compounds are formed at the level where the rules of compound accentuation and *rendaku* are no longer available (Mohanan, 1982); iii) to exploit the functional notion of "double-headedness." (Ueda, 1984) The first approach has inadequacies as we discussed in Ueda (1984). The second approach is also inadequate in that it has to introduce an extremely powerful device of the "loop" in order to allow the returning to the earlier level, as is often pointed out. As for the third approach, Ito and Mester (1984) indirectly shows that the analysis proposed in Ueda (1984), for example, is wrong. Thus, we conclude that all of the three approaches

According to Marantz, Dakota, for example, exhibits a C-V skeleton reduplication, and Yiddin[y] a syllabic skeleton reduplication, and the reduplication of the whole morpheme is "a fairly common phenomenon among the world's languages." Japanese seems to be an instance of the languages which exhibit the reduplication of the whole morpheme. Observe the following examples:

(15) a. hito ⟶ hito-bito[7]
'man' 'people'
b. hana ⟶ hana-bana
'flower' 'various flowers'

The reduplication of the morpheme can be characterized, analogously to the cases of the other types of reduplication, as consisting of the two processes: (i) the addition of a morphemic skeleton to a stem; (ii) the automatic copying of all the other hierarchies of the stem, as shown in (15a'):

(15a')



Recently Kitagawa (forthcoming) points out that a certain class of Sino-Japanese dvandva compounds exhibits an interesting pattern of

are inadequate without discussing their inadequacies in any detail here.

7. *Rendaku* applies to reduplicated forms. However, we do not discuss this issue here, since it is irrelevant to the present discussion.

8. We tentatively assume that a morphemic skeleton is added to the left of the stem. However, we have no specific evidence for this assumption at present. We leave this issue open here.

reduplication, as shown in (16):[9]

(16) a. si-son ⟶ si-si-son-son 'children and grandchildren'
b. mei-haku ⟶ mei-mei-haku-haku 'crystal clear'

One basic characteristic of the reduplication in (16) is that each member of the compounds is reduplicated. Another characteristic is, as Kitagawa (forthcoming) correctly observes, that reduplication must always apply to both members of the compounds simultaneously. Thus, the following forms are ungrammatical:

(17) a. *si-son-son
b. *si-si-son

Although it is not entirely impossible to argue that reduplication applies to each member of this type of compound separately, while assuming that the dvandva compounds like (16) are linear concatenations of roots, the second characteristic is left unexplained in this approach unless some ad hoc constraint on reduplication is introduced, since there is no reason to prevent reduplication from applying to the only one member of the compounds.

Under our analysis of dvandva compounds, on the other hand, these characteristics naturally follow from the structure of the dvandva compounds like (16′),

9. Kitagawa claims on the basis of these data that the process of reduplication itself should be formulated as a three-dimensional operation. We owe an initial inspiration of our analysis of drandva compounds to Kitagawa (forthcoming). Note also that *rendaku* does not apply to reduplicated forms due to the sensitivity of *rendaku* to a morpheme class feature in such a way that it applies only to a native Japanese morpheme, but not to a Sino-Japanese one.

(16') a. $\left[\begin{matrix}[_{N}r\ si\ ] \\ [_{N}r\ son]\end{matrix}\right]$ b. $\left[\begin{matrix}[_{VA}r\ mei\ ] \\ [_{VA}r\ haku]\end{matrix}\right]$[10]

if we assume that each member of dvandva compounds, which are represented as in (16'), constitutes a "simultaneous factor" with respect to morphological or phonological rules in the sense that each member is factorized simultaneously in the application of these rules,[11] and that the "is a" relation as defined as follows (Williams, 1978; 36):

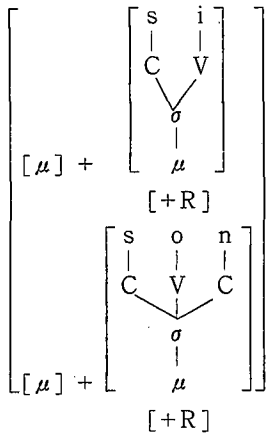
(18) If F is a factor consisting of simultaneous factors $F_1 \ldots F_n$, then F "is a" X if F_1 "is a" X and..., ... and F_n "is a" X.

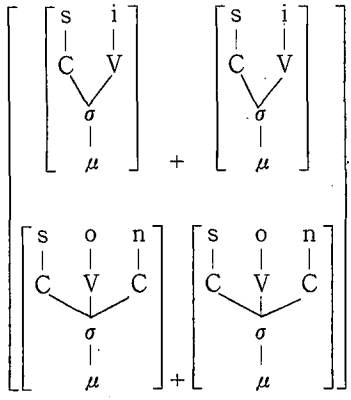
must be met in the application of the morphological or phonological rules. Reduplication is a process sensitive to the idiosyncratic property of lexical items in such a way that each morpheme must be specified as to the applicability of reduplicition, i.e., must be marked, say, either + or − R(eduplication). For example, *ki* 'tree' is marked [+R], as shown by the grammaticality of the reduplicated form *ki-gi* 'trees', while *ha* 'leaf' ic not, as shown by the ungrammaticality of * *ha-ba* 'leaves'

Given these assumptions, the obligatoriness of the simultaneous application of reduplication in dvandva compounds naturally follows, since dvandva compounds consist of "simultaneous factors" by definition

10. Kageyama (1982) claims that Japanese needs lexical categories Verbal Adjective (VA), and Verbal Noun (VN) in addition to the traditional lexical categories N, V, and A. We tentatively adopt Kageyama's system of lexical categories here.
11. Cf.Williams (1978) for the definition of this notion. We use this notion in a technically slightly different way. But it shares its essential content with Williams' notion of "simultaneous factor."

in our analysis, and any morphological or phonological rule must meet the "is a" relation for them to apply to dvandva compounds, i.e., both elements of dvandva compounds must be marked [+R] in the case of reduplication. (18) is an illustration of how reduplication applies to (16'a):

(18) a. 

b. 

(18b) is later linearized by the rule (13), resulting in *si-si-son-son.*

Summarizing, in our analysis of dvandva compounds, the peculiar nature of reduplication in the Sino-Japanese dvandva compound can be naturally accounted for without introducing any ad hoc stipulations about the application of reduplication, given certain assumptions which are independently motivated in syntax.[12] This fact in turn supports the proposed analysis of dvandva compounds.

2.3. Accentuation

We assume in the following discussion that Haraguchi's (1977)

12. See Williams (1978) for detailed discussion.

autosegmental analysis of the tone pattern of Japanese is basically correct. Let us first briefly review his analysis.

Haraguchi assumes that Tokyo has only one tone melody, i.e., HL, and proposes the two basic rules of tone association which link the tone melody to tone-bearing units (V's), i.e., Tone Association Rule (TAR) and Universal Tone Association Conventions (UTAC):

(19) *Tone Association Rule* (TAR)

a. If a string has at least one $\overset{*}{V}$, associate the H tone of the basic tone melody with the leftmost $\overset{*}{V}$.

b. If it has no $\overset{*}{V}$ (i.e., if it is unaccented), associate the H tone of the basic tone melody with the rightmost V.

(20) ## Q V
|
H Q ≠ ... $\overset{*}{V}$ ...

(21) *Universal Tone Association Conventions* (UTAC)

a. All tones should be associated with at least one tone-bearing unit, and conversely, all tone-bearing units should be associated with at least one tone in the tone melody.

b. No association lines should cross.

(20) is a formalized version of (21). Besides these basic rules, Haraguchi asumes two additional rules of tone association, i.e., Initial Lowering Rule (ILR) and Tone Simplification Rule (TSR):

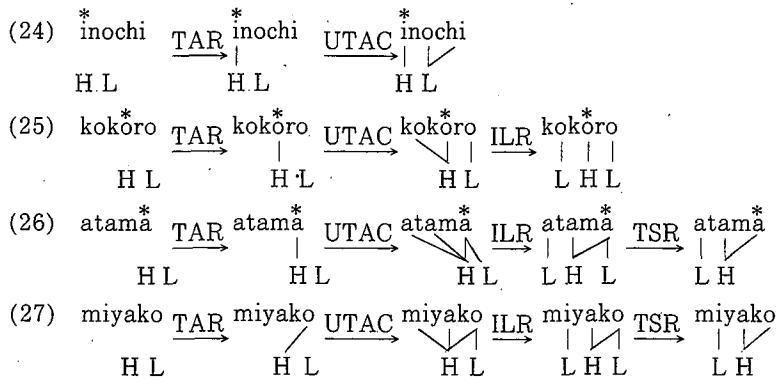
(22) *Initial Lowering Rule* (ILR)

V C_0 V → V C_0 V /## C_0 ——
(H) → (L) (H)

(23) *Tone Simplification Rule* (TSR)

L ⟶ φ / V
H —

Let us now illustrate how these rules account for the four typical tone patterns of words (Note that UTAC applies from left to right):



With this much background, we will discuss the tone pattern of Japanese compounds.

McCawley (1977) proposes the following three rules to account for the tone pattern of noun-noun compounds:[13]

(28) a. In a noun compound X#Y, the accent of Y predominates.
b. If Y is long and final-accented or unaccented, put accent on the first syllable of Y.
c. If Y is short and final-accented, deaccent the whole compound.
(Y is considered to be long when it is more than three moras long or a Sino-Japanese compound.)

The application of these three rules is illustrated in (29a-c), respectively:

13. We assume that accent is placed on syllables rather than moras. See Nishigauchi (1982) for discussion.

(29) a. chúuka + ryóori ⟶ chuuka-ryóori
'chinese' 'cooking' 'Chinese cooking'
b. hanauri + musume ⟶ hanauri-músume
'flower-selling' 'girl' 'girl who sells flowers'
c. natsú + fukú ⟶ natsu-fuku
'summer' 'clothes' 'summer clothes'

In addition to these rules, McCawley points out that there is a set of lexical items which have preaccent, i.e., have accent which is to be placed on the last syllable of the element with which they are combined. *Hi* 'day' and *uta* 'song' are examples of those lexical items:

(30) a. sankan + hi ⟶ sankán-bi
'inspection' 'day' 'inspection day'
b. komóri + uta ⟶ komori-úta
'baby-sitting' 'song' 'lullaby'

We consider this preaccent assignment to be effected by a rule which manipulates accent, and state it as follows:

(31) Place accent on the final syllable of the preceding element.

We assume that this rule is triggered by a set of lexical items which are considered to be preaccented in McCawley (1977).

It should be noted first that there is redundancy in the statements of (28) and (31) in the sense that the application of (28a) is implicitly presupposed in the statements of (28b, c) and (31). We restate (28) and (31) as (32) by eliminating this redundancy: [14]

14. We assume that deletion of the original accent in the second element does not occur. So, if the second element has accent, it or the whole compound

(32) a. Eliminate the accent of the first element of the compound.
b. Place accent on the initial syllable of the second element, if it is long and final-accented or unaccented.
c. Eliminate the accent of the second element, if it is short and final-accented.
d. Place accent on the final syllable of the first element, if the second element is marked [+preaccent].

One basic property of (32), which is directly relevant to our present discussion, is that the structural descriptions of (32) must specify that the element whose accent is manipulated is followed (as in (32a,d)) or preceded (as in (32b,c)) by the other element of the compound, however they are formulated.[15] The basic property being characterized as above, the inapplicability of (32) to dvandva compounds follows from the nature of (32) and the representation of dvandva compounds in our analysis, since dvandva compounds, being assumed to be stacks of lexical items, simply do not satisfy the structural descriptions of (32).

Next, we account for the phrasal accent pattern of dvandva compounds in the following way. We first assume that (32) are the rules of lexical phonology, which apply in the lexicon, while the rules of tone association (19-23) are those of postlexical phonology.[16] Under this assumption, the phrasal accent pattern of dvandva compounds is a consequence of the

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will have two accents after the application of (32b) or (32d). However, this will cause no problem because of the nature of TAR, as we will see later.

15. Junko Ito pointed out to us that (32a) could be a consequence of the extrametricality of the first element in Japanese compounds. (Cf. also Ito and Mester (1984)) This assumption of the extrametricality of the first element in Japanese compounds, however, does not affect the present discussion, as far as the notion of extrametricality is defined in linear terms.

16. Kiparsky (1982b; 3) presents a set of characteristic properties that distinguish between the rules of lexical phonology and those of postlexical

inapplicability of (32) to them and the nature of TAR (19), which associates the H tone of the basic tone melody with the leftmost accented V if there is one. Observe the following examples of a PP and a dvandva compound, which are reproductions of (6a) and (7a):

(33) a. kokóro + máde ⟶ kokóro máde
b. natsú + fuyú ⟶ natsú-fuyú

In our analysis, the accent of both lexical items are retained in both PP's and dvandva compounds, as shown in (33), and the predominance of the leftmost accent and the suppression of the other(s) automatically follow from the fact that TAR (19) associates the H tone with the leftmost accented V.[17]

2.4. Rendaku

Although the phenomenon of *rendaku* has been extensively studied by traditional and generative grammarians, no clear characterization of the phenomenon has been proposed yet. Particularly, it is well-known that the rule of *rendaku*, which applies to certain types of compounds and derivatives, is subject to numerous mysterious conditions, among which are included: a) the second element containing the target segment

phonology. It seems rather clear that the rules of compound accentuation have properties of lexical phonology, such as cyclicity, word-boundedness, having lexical exceptions, etc., and the rules of tone association those of postlexical phonology, such as applying once, non-word-boundedness, automaticity, etc. This fact supports our assumption in the text.

17. We assume the convention that only one basic tone melody is allowed for a single tonological domain, and that, if there is more than one basic tone melody in the domain, the leftmost melody is retained, while the others are eliminated. This is essentially the same as Haraguchi's (1977) proposal.

of *rendaku* must be a native Japanese morpheme; b) the element containing the target segment must be on the right branch (the Right Branch Condition) (Otsu, 1980); c) the second element containing the target segment must not contain any voiced obstruents. (Lyman's Law) However, there is one clear aspect of *rendaku* which is crucial to our discussion, i.e., *rendaku* applies only when the element containing the target segment is preceded by the other element of compounds or derivatives. Otsu (1980;217), forexample, proposes the following formulation of *rendaku*:[18]

(34) C (onsonant) $\longrightarrow$ [+Voice] / $[_N$ X[#___Y

where (i) X $\neq$ null and

(ii) Y does not contain any voiced obstruents.

This seems to be a necessary property of *rendaku* in any characterization of it. Thus, if this is correct, the inapplicability of *rendaku* to dvandva compounds simply follows from this nature of *rendaku* and the stacked representation of dvandva compounds in our analysis, since dvandva compounds simply do not meet the structural description of *rendaku* in our representation of them.

Summarizing, we have shown that the peculiar pattern of reduplication in the Sino-Japanese dvandva compound provides a support for our representation of dvandva compounds, and that the inapplicability of the rules of compound accentuation (32) and the rule of *rendaku* to dvandva compounds naturally follows from the nature of these rules and the stacked representation of dvandva compounds.

18. Cf. Ito and Mester (1984) and Ueda (1984) for discussions on the possibilities of different formulations of *rendaku*.

3. Linearization

One aspect of the process of linearization to be made clear is at which stage it applies. We reproduce our formulation of this process (13) for convenience's sake:

(13) $\begin{bmatrix} X_1^n \\ \vdots \\ X_n^n \end{bmatrix} \longrightarrow [X_1^n \cdots X_n^n]$

There seem to be two possibilities. One is that it applies after the application of all the rules of lexical phonology, i.e., immediately before dvandva compounds are inserted in syntactic structures. The other possibility is that it applies at the end of each cycle. We will show in this section that there are at least two observations which suggest the correctness of the latter possibility. We assume in accordance with Kiparsky (1982a) that lexical categories such as N, V, A, etc., whether they are words or roots, constitute cyclic domains.[19]

The first observation is concerned with the rules of compound accentuation (32), especially the rule of preaccent assignment (32d). First, observe that (32) applies cyclically, as shown in:

(35) a. [[iga* + kuri*] + atama*] ⟶ i*ga-guri-a tama
'burr' 'chestnut' 'head' 'a head like a chestnut in burrs'

b. underlying representation:
$[_{N_5}\,[_{N_3}\,[_{N_1}\,\text{iga}^*]\,[_{N_2}\,\text{kuri}^*]]\,[_{N_4}\,\text{atama}^*]]$

19. Our assumption differs from Kiparsky (1982b), where he modified the notion of cycle in such a way that only words, but not bound morphemes, are cyclic domains.

c. N_1, N_2 : No rule applies.
d. N_3 : $[_{N_3}$ iga-guri] by (32a, c) and ***rendaku***
e. N_4 : No rule applies.
f. N_5 : $[_{N_5}$ iga-guri-$\overset{*}{a}$tam$\overset{*}{a}$] by (32b)

No rule applies in the N_1 and N_2 cycles. Then, in the N_3 cycle, (32 a,c) apply, and eliminate the accents of ***iga*** 'burr' and ***kuri*** 'chestnut', and ***rendaku*** also applies in this cycle. In the N_4 cycle, again no rule applies. Then, finally, in the N_5 cycle, (32b) applies, placing accent on the initial syllable of ***atama*** 'head'. Its second accent is suppressed by the application of TAR, followed by that of ILR, and we get the correct tone pattern of this compound as represented in (35a), where the upper line indicates high pitch, the underline low pitch, and the vertical line a change of pitch.

Now consider the case of a compound in which a dvandva compound is embedded and the head of the whole compound is a lexical item which triggers the preaccent rule (32d), e.g., ***sake*** 'wine':

(36) a. [[ky$\overset{*}{o}$o + d$\overset{*}{a}$i] + sake ⟶
'elder brother' 'little brother' 'wine'
kyo|o-dai|-zake
'brotherhood wine'

b. *underlying representation*:

$$[_{N_5}\left[\begin{array}{l}[_{N_1^r}\ ky\overset{*}{o}o]\\ [_{N_3^r}[_{N_2^r}\ d\overset{*}{a}i\ ]\end{array}\right][_{N_4}\ sake]]$$

c. N_1^r, N_2^r, N_3^r, N_4: No rule applies.
d. N_5 : $[_{N_5}\left[\begin{array}{l}[kyoo]\\ [dai\ ]\end{array}\right]$-sake] by (32a)

d'. N_5 : $[_{N_5}\begin{bmatrix}[ky\overset{*}{o}o] \\ [d\overset{*}{a}i\ ]\end{bmatrix}$-zake] by (32d) and *rendaku*

No rule applies in the N^{r}_{1-3} and N_4 cycles. In the N_5 cycle, (32a) first applies in the across-the-board fashion, and eliminates the accents of both *kyoo* and *dai*. Then, (32d) applies again in the across-the-board fashion, placing accents on the final syllables of both lexical items, and *rendaku* also applies in this cycle, changing *sake* into *zake*. This is the derivation under the assumption that linearization applies after all the rules of lexical phonology. However, in this derivation, after linearization applies to (36d'), we get the ungrammatical *kyo͡o-da͡i-zake*. Thus, we mnst assume that linearization applies in the N^{r}_{3} cycle, i.e., at the cycle end, in order to get the correct tone pattern as represented in (36a). This constitutes evidence for the latter possibility.

The other observation is concerned with allomorphemic alternation. As Kageyama (1982) points out, a morpheme with the meaning "day," which we represent as *KA*, has two allomorphs, *ka* and *nichi*, whose occurrence is determined by the preceding element. Observe that the morphemes *san* 'three' and *yon* 'four' allow only one of these two allomorphs to occur when *KA* is attached to them:

(37) a. *san-ka 'three days'
b. san-nichi

(38) a. yon-ka (yok-ka) 'four days'[20]
b. *yon-nichi

20. The form *yon-ka* is always changed into *yok-ka*. However, this is irrelevant to our present discussion.

The morphemes *san* and *yon* happen to form a dvandva compound *san-yon* 'three or four', and if this compound is combined with *KA*, we get *san-yokka* 'three or four days', but not *san-yon-nichi*. In order to get the correct result, we must linearize *san-yon* before we reach the topmost cycle where morpheme alternation occurs, i.e., we must linearize it at the end of the cycle immediately dominating the dvandva compound. Therefore, this provides another support for the claim that linearization applies at the cycle end.

4. Conclusion

We have shown in this paper that the peculiar properties of dvandva compounds in Japanese can be naturally accounted for if we assume that dvandva compounds are stacks of lexical items in underlying representations. Although our discussion is exclusively based on the data from Japanese, the proposed analysis seems to be of general theoretical interest. Particularly, it is interesting that our analysis is, in a sense, a natural extension of Williams' analysis of coordinate structures in syntax. It may turn out to be the case that our analysis leads to a general claim that coordinate structures should be universally represented as stacks of elements whether they are in syntax or morphology. The issue is open for further study.

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