Prosodic typology and compound – phrasal contrasts

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ABSTRACT

This study investigates pitch (f_0) and timing cues that distinguish compound words and phrases in left and right branching structures in three typologically different languages, English: a stress-accent language, stress timed, Japanese: a pitch-accent language, mora timed and Vietnamese: a tone language, syllable timed.

1. INTRODUCTION

In English, compounds are distinguished from phrasal constructions, by a contrasting pattern of pitch prominence and by duration characteristics that appear to have their origin in the fact that compounds are required to conform to word prosody. i.e.: licensing of a single accent-bearing syllable, and being subject to temporal compression effects associated with affixation in polysyllabic word forms (Lehiste, 1972). The phonological features which distinguish compounds from phrases are closely related to prosodic cues that (optionally) permit speakers to resolve 'attachment ambiguities', which are traditionally termed 'juncture'.

Juncture is variously realized phonetically in different languages by boundary accent marking, pause breaks, pre-boundary lengthening, and fundamental frequency re-setting. We assume that junctural disambiguation of structural ambiguity is universal in phrase level phonology, though phonetically implemented in various ways depending on a language's prosodic and syntactic type (e.g.: left versus right branching). We postulate that not all languages possess independent prosodic means of distinguishing phrases from compounds (words). In this paper we undertake an acoustic analysis of prosodic features that distinguish compounds and phrases, and which resolve structural ambiguities in noun phrases in three typologically different languages: English (a stress-accent language, with stress timing), Japanese (a pitch-accent language, with moraic timing) and Vietnamese (a tonal language with syllable timing).

A common methodology was used in each of the three experiments reported here. Six native speakers (2 for each language) read pairs of phrases spoken in 'the careful but natural style of a newsreader which contrasted left versus right branching readings of a pair of noun phrases, or phrasal versus compound construction. The readers all had considerable experience in recording items for language teaching or phonetic experiments. Multiple tokens (3) of the contrasts were recorded, digitized, phonetically annotated, and analyzed for the temporal and voice pitch (f_0) parameters known to be effective acoustic cues to linguistic stress, and phrase boundary marking: i. the locus and duration of any junctural pauses, ii. Pre-pausal lengthening, and iii. mid-vowel f_0 measurements.

2. ENGLISH

The English data set comprised 7 triplets involving contrasts between left and right- branching structures in Phrasal compounds and left-branching embedded noun phrases:

1a. A black-bird cage	$[[\text{adj - n}]_{CP}\ \text{n}]_{NP}$
1b. A black bird-cage	$[\text{adj }[\text{n - n}]_{CP}]_{NP}$
1c. A black bird cage	$[[\text{adj n}]_{NP}\ \text{n}]_{NP}$

Each triplet was elicited three times in separate readings of the stimulus set by two readers, resulting in 126 (7 x 3 x 3 x 2) items for acoustic analysis. , Both readers were native speakers of Australian English, a (the author), and a Linguist with professional voice training and acting experience.

2.1 ENGLISH RESULTS

As expected, word or syllable duration and peak vowel fundamental frequency, normalized for individual speech rate and intrinsic f0 were effective in classifying the utterances into the three target stress groups. The duration differences are shown in Fig.1, where the timing patterns of the left and right branching phrasal compounds are contrasted with the left branching (pre-modified) noun phrase.

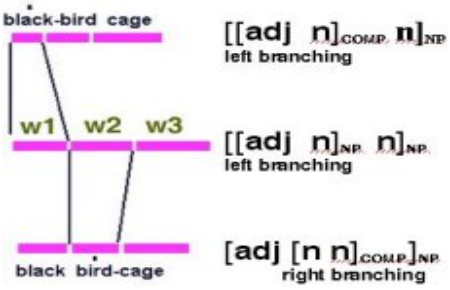

Figure 1. Word duration in English phrasal compounds

Duration was a more effective cue than f0 for identifying stress patterns. A linear discriminant function analysis successfully classified 82.5% of tokens into one of the three target categories on the basis of rate-normalized first and second word duration measurements (w1 and w2 in Fig.1 above.) The successful classification rate rose to 91.2% when peak vowel f0 measurements for w1 and w2 were included in the discriminant function.

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Temporal compression associated with the compound constituents is clearly evident from Fig.1. Notably, the accent-bearing constituent of the compound word undergoes more temporal compression than the unaccented constituent, when compared with their respective counterparts in the full noun phrase. This word shortening effect, first reported by Lehiste (1972) has been observed to operate in attenuated form in discourse reading (Farnetani and Cosi, 1988). However, the precise mechanism of this temporal compensation in compound words remains unclear and merits further study.

The role of juncture in prosodic disambiguation was marginal in the English data. Were it operating, pre-pausal lengthening would be expected on W1 in right-branching constructions or on W2 in left-branching constructions. No evidence of this was found. However, what we interpret as potential junctural breaks (silent periods > 50 m.sec) occurred between W1 and W2 on a significant minority (15/42 = 36%) of right-branching compound phrases (1b. above). Although English strongly favors right- branching at clause level syntax, it is left branching in its phrase structure.

3. VIETNAMESE

Vietnamese is a highly analytical language, with a one-for-one correspondence between syllables and morphemes and a virtual absence of inflectional morphology. Compounding is the principle word-building morphological process of which there are several subtypes. In noun phrases, head nouns are right-modified by adjectives or stative verbs. Thus, noun phrases in Vietnamese are basically right-branching. Vietnamese is a tone language, with 5 or 6 tones depending on regional dialect. It has no system of lexical or word stress.

Three word noun phrases (illustrated in 2a-b below) may be constructed in Vietnamese, which have distinct right or left-branching readings, which may be disambiguated with prosody though they are usually not, with speakers relying on context.

2a. Bao [gối vàng] [Noun [Noun Adj.]$_{NP}$]$_{NP}$

2b. [Bao gối] vàng [[Noun Noun]$_{NP}$ Adj.]$_{NP}$

case pillow yellow

While 2b above may appear to contain a [noun - noun] compound, such forms are regarded as NPs by Vietnamese grammarians. They are semantically compositional and therefore phrase like, quite distinct from the non-compositional compound form in 3a (meaning: *rose*):

3a. Lọ [hoa hồng] [Noun [Noun Adj.]$_{CP}$]$_{NP}$

3b. [Lọ hoa] hồng [[Noun Noun]$_{NP}$ Adj.]$_{NP}$

vase flower pink

Thus, Vietnamese grammar permitted us to construct pairs of left and right-branching noun phrases containing an embedded NP (as in 2a-b), and to contrast the prosodic behavior of such pairs with phrasal constructions containing the same left versus right branching ambiguity, but where one member of the pair is clearly a phrasal compound (as in 3a). Comparison of the acoustic cues associated with left and right-branching readings in the two types of minimal prosodic pairs (2a-b vs. 3a-b) should inform us as to whether Vietnamese registers an independent distinction between compound and phrasal constructions.

A series of two-way analyses of variance (ANOVA) was undertaken, with Phrase type (2 levels: [NP-NP] vs. [NP-CP]) and Direction of branching (2 levels: Left vs. Right) as independent variables. The dependent variables used in these analyses were, by turn: juncture duration, syllable duration, and f_0. For syllable duration and f_0, separate ANOVAS were undertaken at each position in the phrase, with positions 1 and 2 critical for pre-pausal lengthening effects in right and left branching respectively.

3.1 Results - Vietnamese data

Juncture: The direction of branching was clearly marked by a junctural pause at the anticipated location (after syllable 1 for right-branching structures and syllable 2 for left branching structures) in all but one or two items. The break was significantly longer ($p < 0.0001$) in left-branching than in right branching structures (fig. 2.). Vietnamese is right branching in its NP structures. Left branching phrase structure may be regarded as the *marked* case.

Pre-boundary lengthening: Two way ANOVAS, with Phrase type (NP-NP vs NP-CP) and Direction of embedding (Right - Left) as independent variables and syllable duration as the dependent variable were conducted at syllable positions one, two and three in the contrasting pairs of phrases. For all three ANOVAS, there was no effect of Phrase type, or any significant interactions between Phrase type and Direction of embedding. However, there was a highly significant main effect of Direction of embedding upon the duration of the first and second syllables, as shown in Fig. 2. Lengthening occurs on the syllable immediately preceding the juncture break. Syllable 3 was subject to phrase final lengthening in all conditions.

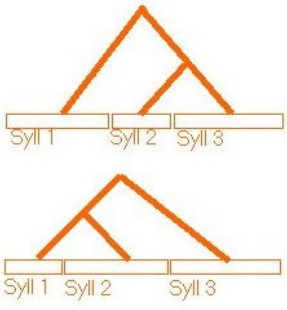

Figure 2. Vietnamese: pre-boundary lengthening and direction of branching.

Fundamental frequency (f0): Three 2-way ANOVAS were conducted, with Phrase type and Direction of embedding as the treatment conditions and f_0 of the first, second and third syllable as the dependent variable in successive analyses. A single significant main effect ($p < .003$) for phrase type was observed for the first syllable position. No significant

interactions were found. The most likely cause of this effect was nothing to do with prosodic cues to constituent structure but simply the fact that the first syllable in the NP-NP set has a higher proportion of rising or +high tones than the NP-CP set.

3.2 Conclusions: Vietnamese data

Left and right-branching readings of Vietnamese 3 word phrases seem to be phonetically realized by the same prosodic device of juncture assignment in the absence of contextual cues and under elicitation conditions that highlight the semantic contrast. The lack of any significant interaction effects between Phrase type and Direction of branching indicates that Vietnamese has no prosodic device for marking the word-like status of compounds or for differentiating them from phrasal constructions.

4. JAPANESE

In contrast to Vietnamese, Japanese permits a more clear-cut comparison of prosodic structures at the word and phrase levels. It is possible to construct minimal prosodic pairs at both word and phrase levels:

Japanese	English
4a. [nurí **g**asa] ire	[lacquered umbrella]case
4b. nuri [kasá ire]	lacquered [umbrella case]
5a. óokina [nooen-no óonaa]	a big [farm owner]
5b. [óokina nooen-no] óonaa	a [big farm] owner

Examples (4a-b) above are compound expressions and (5a-b) phrasal constructions in Japanese. The application of the voicing assimilation rule rendaku, which only applies word-internally, clearly signals the compound status of (4a-b) and the inflectional suffix (genitive case) on nooen 'farm' signals the phrasal status of (5a-b). The left and right branching readings of (4a-b) are disambiguated by pitch accent in careful reading (Tokyo dialect). The left and right branching readings of the phrasal constructions (5a-b) are also prosodically disambiguated in careful speech (Kubuzzono, 1992), but by different cues than in the case of the compounds.

It was expected that fundamental frequency changes would play a more prominent role in phrase boundary marking in Japanese than in Vietnamese, through the downstep of accentual prominence within the phrase, and fundamental frequency re-setting which occurs between phrases at phrase boundaries. Downstep is a mechanism whereby the pitch register for marking accentual prominences is lowered with each successive occurrence of a pitch accent within a phrase. At the end of the phrase, the pitch register is re-set for the next phrase, producing a 'sawtooth' pattern of intonation contours. The re-setting of pitch register at phrase boundaries may involve an extra increment of f_0 raising, which Kubozono (1989) termed a 'metrical boost'. Downstep within a phrase and F0 resetting across a phrase boundary (with some 'metrical boost') is illustrated in figures 3 and 4 below.

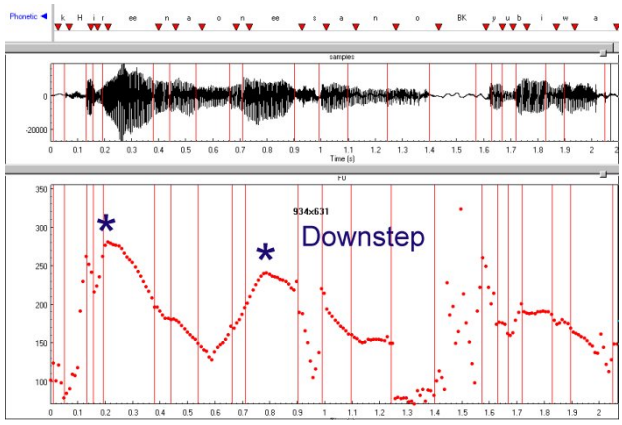

Figure 3. Downstep within a phrase in Japanese

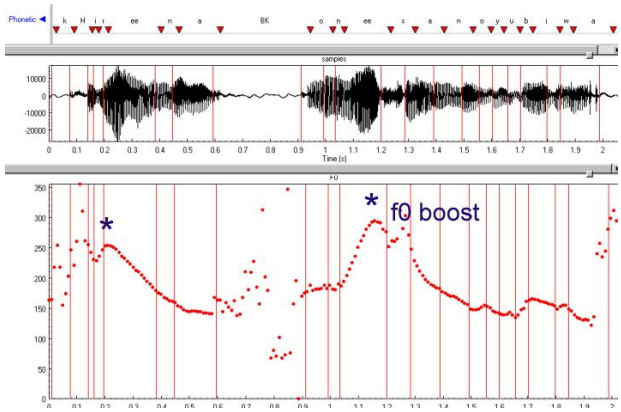

Figure 4. F_0 resetting across a phrase boundary

Results Japanese data

Juncture breaks: Very few juncture breaks were observed in compound expressions and in phrases juncture breaks were only consistently found in right-branching structures (Table 1).

	Left branching	Right branching
Compounds	.04	.14
Phrases	.23	.95

Table 1. Proportion of juncture breaks at constituent boundaries in Japanese.

Pre-boundary Lengthening: Three two-way ANOVAS were conducted with Phrase type and Direction of branching as the independent variables and the duration of the first, second and final words in the compound/phrase as successive dependent variables. There was a significant main effect for Direction of branching for the first word only. There were no significant interaction effects. The main effect for Phrase type simply reflected the differing number of syllables that made up the words in the compound and phrasal expressions. It is apparent from Figure 5 that the greater length of the first word can be attributed to a pre-pausal lengthening effect in a right-branching structure. This lengthening effect on the first syllable of a right branching structure was found in both compound and phrasal expressions, in spite of the fact that few junctural breaks were observed in compound expressions.

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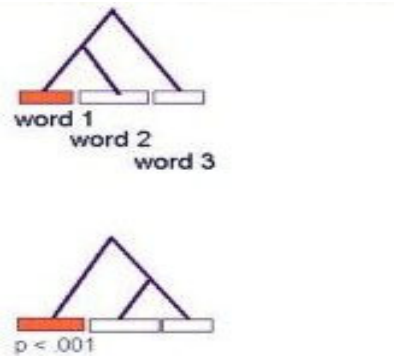

Figure 5. Word duration and direction of branching in Japanese

To further investigate the mechanism of the word lengthening effect, we examined patterns of syllable duration, in particular, lengthening on the final and the penultimate syllables of a word preceding a potential juncture. (i.e.: the first word in right-branching phrase, compared with the first word in the left-branching phrase). The lengthening effect was found to be confined to the final syllable of the word before the potential juncture break (Figure 6).

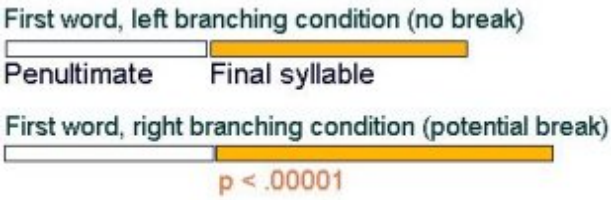

Figure 6. Syllable lengthening before a potential juncture break in Japanese.

Fundamental frequency (f0): To assess effects of downstep within phrase boundaries and pitch register re-setting across phrase boundaries, mid vowel fundamental frequency measurements were taken on the two syllables that preceded and followed the point of left branching and the point of right branching (i.e.: f_0 measures on the penultimate and final syllables and the first two syllables following an internal phrase boundary). Two separate series of 2-way ANOVAS were conducted, one on the compound expressions and another on the phrasal constructions. The two factors or independent variables were Items (7 levels) and the Direction of branching (2 levels) and the dependent variable was the f_0 of syllables at the relevant position in the phrase.

As expected, there were no systematic differences attributable to the Direction of branching in the compound expressions. However, there was a highly significant main effect of Direction of branching in the f_0 values at all but one position in the phrasal constructions. The results (Fig. 7) show the effects of f_0 resetting across the internal phrase boundary in the right branching condition and a corresponding absence of f_0 resetting in the left branching condition. Both graphs have the same form but the f_0 changes with syllable position are more clearly marked for the right- branching items and the pattern of pitch changes is consistent with the occurrence of a phrase boundary between S2 and S3. The peak at S4 in the case of the right branching items is consistent with phrase boundary f_0 re-setting. (One might expect to see a peak at S3 were it not for the fact that Japanese has a rule of 'initial lowering' that lowers f_0 on the first syllable of a phrase.) The minor pitch peak at S4 for the left branching items is attributable to a down-stepped accent.

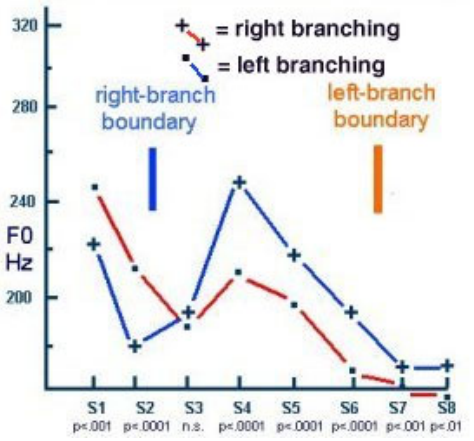

Figure 7. F_0 resetting and direction of branching.

5. CONCLUSIONS

In speaking conditions that encourage maximization of perceptual (phonological) contrasts, Vietnamese, Japanese, and English speakers have access to a universal juncture marking strategy for phrase structure disambiguation. In all three languages, juncture is preferentially used to signal departures from the unmarked direction of phrase branching. Pre-pausal lengthening appears to be the most reliable acoustic expression of juncture. Compounds are distinguished from phrases in Japanese and English by de-accenting. Vietnamese appears to lack any distinctive word prosody for compound formation.

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