

THE NATURE OF LINEAR INFORMATION IN  
THE MORPHOSYNTAX-PF INTERFACE

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Abstract

This paper claims that the hierarchical structure of morphosyntax is mapped onto a linear sequence of elements with prominence and different strengths of juncture, which play a role in parsing the structure intended by the speaker. The mapping of left-branching and right-branching structure shows asymmetry in the strengths of juncture. This junctural asymmetry comes from the phonetic implementation of speech signals. It is argued that the strong juncture in left-branching structure makes it quasi-compound. Unmarked word-stress location works as a constraint on complement movement, deriving left-branching from right-branching structure in the base, thus taking the place of a head-directionality parameter. This analysis therefore dispenses with the need for linear information in morphosyntax.\*

**Keywords:** *morphosyntax, stress, disjuncture, branching direction, compounding*

1. Introduction

The minimalist program claims that morphosyntax is free from linear order, which is determined at PF. However, the mechanism of linearization at the morphosyntax-PF interface has not been discussed in detail. This paper discusses how morphosyntactic structure is mapped onto PF representation with prosodic features such as stress and the strength of juncture.

Section 2 discusses the encoding of morphosyntactic structures into linear phonetic representations and the building of hierarchical structure using phonetic information. It is argued that the juncture between immediate constituents in left-branching structure is stronger than in right-branching structure. Section 3 claims that this junctural asymmetry leads to the stress constraint on complement movement, which determines head-complement orders in languages. Section 4 offers concluding remarks.

## 2. Linearization of Hierarchical Structure

### 2.1. Linearization with Prosodic Boundaries

In this section, I argue that hierarchical structure is encoded as stress and the juncture between elements. Let us consider the structure in (1), where  $\alpha$  merges with  $\beta P$  to constitute  $\alpha P$ .

$$(1) \quad [\alpha P \alpha \beta P]$$

Kayne's (1994) Linear Correspondence Axiom (LCA) requires the structure in (1) to be linearized into the base order of head-complement,  $\alpha \beta P$ . I propose that the constituent boundary between head  $\alpha$  and complement  $\beta P$  is spelled out as a prosodic boundary at PF, which is represented as a slash in (2).

$$(2) \quad \alpha / \beta P$$

Kayne (1994: 47) argues that complement moves to the specifier position of the head (or of a higher functional head associated with it) to derive the structure in (3).

$$(3) \quad [\alpha P \beta P [\alpha' \alpha \beta P]]$$

Here the  $\beta P$  in the original complement position, which has no phonetic features, and  $\alpha'$  immediately dominating the  $\beta P$  are italicized to show that they are invisible at PF. The LCA requires (3) to be linearized into the order in (4).

$$(4) \quad [\alpha P \beta P \alpha]$$

One might expect that the constituent boundary between  $\beta$ P and  $\alpha$  in (4) would be spelled out as the same type of prosodic boundary as that in (2), as shown in (5).

(5)  $\beta$ P /  $\alpha$

However, a number of phenomena show that the boundary in (5) is weaker than that in (2). For example, Wagner (2005) observes that prosodic phrasing in German shows an asymmetry between OV and VO orders: a VP with OV order is pronounced as a prosodic phrase while a VP with VO order is pronounced as two prosodic phrases, as shown in (6).

(6) a. (*Sie hát*) (*einen Tángo getanzt*)

she has a-Acc tango danced

‘She has danced a tango.’

b. (*Sie tánzte*) (*einen Tángo*)

she danced a-Acc tango

‘She danced a tango.’

In (6a), a left-branching VP [*einen Tángo getanzt*] is included in a prosodic phrase. In (6b), a right-branching VP [*tánzte [einen Tángo]*] is divided into two prosodic phrases.

Booij (2010: 100) argues that Dutch OV combinations such as *piano spelen* ‘to play the piano’ can form tighter syntactic constructs than VPs; he calls such combinations quasi-incorporation. For example, OV combinations can appear in *aan het* ‘at the’ constructions and verb raising constructions, as shown in (7a) and (7b).

(7) a. *Jan is {piano aan het spel-en/aan het piano spel-en}*

John is {piano at the play-INF/at the piano play-INF}

‘John is playing the piano.’

b. ... *dat Jan {piano wilde spelen/wilde piano spelen}*

... that John {piano wanted play/wanted piano play}

‘... that John wanted to play the piano.’

The object of a verbal infinitive normally appears before *aan het* or *wilde*, as in the first option in each of the items enclosed in braces. However, OV combinations can appear after them, as in the second option. This kind of quasi-incorporation occurs in OV order but not in VO order in Germanic languages (Danish, Dutch, German, Norwegian and Swedish) (see Booij (2010: 96) and references cited there). Quasi-incorporation is also seen in OV languages such as Japanese and Hindi. Although some Oceanic languages are reported to have quasi-incorporation in the form of VO, for example, Niuean (VSO) and Tongan (VOS/VSO), these languages do not have alternative OV order. As far as I know, in languages with both VO and OV orders, it is OV that may have quasi-incorporation.

These facts show that the boundary between complement  $\beta P$  and head  $\alpha$  in left-branching structure in (5) is weaker than that in right-branching (2). In other words, left-branching structure is a quasi-compound. Tokizaki (2008b) and Tokizaki and Kuwana (to appear a, b, c) show more evidence of junctural asymmetry, which includes sequential voicing in Japanese, *n*-insertion in Korean, interfixation in three word compounds in Dutch, prefix/suffix asymmetry and the agglutinative nature of OV languages.

In sum, phrase structure is linearized with prosodic boundaries as shown in (8a) and (8b); in the latter I use a backslash instead of the slash in (5) to show a weak boundary between  $\beta P$  and  $\alpha$ .

- (8) a.  $[\alpha_P \alpha \beta P] \rightarrow \alpha / \beta P$   
 b.  $[\alpha_P \beta P [\alpha' \alpha \beta P]] \rightarrow \beta P \backslash \alpha$

The asymmetry in juncture lies at the basis of head-complement orders in languages, as I will argue in section 3.

## 2.2. Linearization with Prominence

The second point involving linearization is that in most languages syntactic objects are spelled out with prominence, such as stress and accent. I assume Cinque's (1993) null theory of stress assignment, which claims that the most deeply embedded element in a structure receives stress. Assuming Kayne's (1994: 7) asymmetric phrase structure, schematic examples of left-branching and right-branching structure are (9a) and (9b), where A and C are dominated by a non-branching category.

- (9) a. [[[A] B] C]  
 b. [A [B [C]]]

The sequences in (9a) and (9b) are spelled out with prominence on the most deeply embedded element (A in (9a) and C in (9b)), as well as prosodic boundaries, as in (10a) and (10b) (prominent elements are shown in bold face).

- (10) a. ∅∅∅ **A** ∅ B ∅ C ∅  
 b. / A / B / **C** ///

Thus, structure in morphosyntax is encoded as prominence and juncture in the linear representation in PF.

Here let us consider the difference between compounds and phrases consisting of two words such as (11a) and (11b).

- (11) a. **greenhouse**  
 b. green **house**

If Cinque's (1993) rule is on the right track, then the element with stress must be most deeply embedded in a structure. The stress in the compound (11a) and phrase (11b) shows that (11a) and (11b) have the structures in (12a) and (12b), where the stressed element is dominated by a non-branching category.

- (12) a. [[**green**] house]  
 b. [green [**house**]]

These structures are spelled out as (13) by (8).

- (13) a. ¥¥ **green** ¥ house ¥  
 b. / green / **house** //

Thus, we can explain the intuition that the juncture in the compound (11a) is stronger than that in the phrase (11b): the prosodic boundaries in (13a) are weaker than those in (13b).

Here, let us consider Japanese compounds.

- (14) a. *ken* + *gikai* → [[ *ken*]-*gikai*]  
 HL HLL LH - HLL  
 prefecture assembly  
 ‘prefectural assembly’  
 b. *ken-gikai* + *giin* → [[[*ken*]-*gikai*]-*giin*]  
 LH-HLL HLL LH - HHH-HLL  
 prefecture-assembly member  
 ‘a member of the prefectural assembly’

Compounds have LH..-HL.. pitch contour with the pitch-fall (HL) in the rightmost constituent. The pitch-fall has traditionally been assumed to be accent in Japanese. If we take the pitch-fall as a counterpart of stress, compounds such as (14) are counterexamples to the generalization that stress is assigned to the most deeply embedded element, i.e. the first constituent in compounds (14). However, it is plausible to argue that Japanese has stress on the initial mora in words and compounds. This becomes clear in emphasized words and compounds. In stress languages, emphasis is expressed by intensity on the stressed syllable (e.g. *lin-guis-tics!*). In Japanese, emphasized words have intensity on the first mora and not on the mora with pitch-fall, as shown in (15) and (16).<sup>1</sup>

- (15) a. ***an**ata!*                      b. \**an**ata**!*  
 LHL                                      LHL

‘You!’

- (16) a. *ken-gikai!*      b. \**ken-gikai!*

LH-HLL

LH-HLL

‘Prefectural assembly!’

(in non-contrastive reading)

- (17) a. *ken-gikai-giin!*    b. \**ken-gikai-giin!*    c. \**ken-gikai-giin!*

LH-HHH-HLL

LH-HHH-HLL

LH-HHH-HLL

‘A member of the prefectural assembly!’

(in non-contrastive reading)

Then, Japanese compounds have stress on the initial element, conforming to the generalization that the most deeply embedded element receives stress.<sup>2</sup>

### 2.3. Parsing with Prosodic Information

Let us consider how the hearer parses the phonetic representation with prominence and juncture. I propose the rules in (18), which formalize the process that hearers follow in constructing morphosyntactic structure from the prominence and prosodic boundaries in utterances.

- (18) a. Merge the element with primary prominence with the adjacent element separated from it by fewer prosodic boundaries.
- b. Merge the constituent resulting from the preceding Merge with the adjacent element separated from it by fewer prosodic boundaries.

These rules apply to the phonological representations in (10) (with another element X added) to give (19).

- (19) a.  $X \text{ ¥¥¥ } A \text{ ¥ } B \text{ ¥ } C \text{ ¥} \rightarrow X [[A] B] C \rightarrow X [[[A] B] C]$

- b.  $/ A / B / C /// X \rightarrow A [B [C]] X \rightarrow [A [B [C]]] X$

First, the prominent element, A in (19a) and C in (19b), is merged with B (not with X) by (18a). Next, the resulting constituent  $[[A] B]$  and  $[B [C]]$  merges with C in (19a) and A in

(19b) (not with X) by (18b). (19a) and (19b) correspond to compounds and phrases such as (20a) and (20b).

- (20) a. ¥¥¥ **waste** ¥ disposal ¥ plan ¥ → [[**waste**] disposal] plan →  
 [[[**waste**] disposal] plan]
- b. / go / to / **school** /// → go [to [**school**]] → [go [to [**school**]]]

The details of parsing and structure building are important, but I omit them here for reasons of space (see Tokizaki (2009)).

## 2.4. Junctural Asymmetry and Phonetic Implementation

Let us consider why the juncture between elements is stronger in left-branching structure than in right-branching structure. The junctural asymmetry can be ascribed to the linear implementation of speech signals, whose asymmetry is found in a number of phenomena. First, the pitch goes down from the beginning to the end of a sentence in both tone and stress languages ( $F_0$  downtrend or declination (Ladd 1996: 73)). Second, Ghini (1993) proposes the principle of increasing units, which claims that short phonological phrases ( $\phi$ ) precede long phrases in a sentence (for a performance theory of word orders, see the references in the Introduction).<sup>3</sup>

- (21) a. .. ( $\phi$  ) ( $\phi$  ) ( $\phi$  ) ..
- b. \*.. ( $\phi$  ) ( $\phi$  ) ( $\phi$  ) ..

The principle is observed in (21a) but not in (21b). Third, it has been pointed out that there is an asymmetry in prosody between pre-focus and post-focus positions. Nagahara (1994) observes that there is no intervening Major phrase boundary between any focus constituent and the end of a sentence (No Post-Focus Phrasing, cf. Tancredi (1992), Sugahara (2003)), as shown in (22).

- (22) a. (MajP ) (MajP ) (MajP ) (FOC )



- b. \* (MajP ) (MajP ) (MajP ) (FOC ) (MajP ) (MajP )

(22b) is ruled out because of the Major phrase boundaries in the post-focus position.

These facts show that  $F_0$  downtrend and post-focus low pitch make it difficult to pronounce the disjuncture in left-branching structure. If prosodic phrasing represented major constituent boundaries without junctural asymmetry, left-branching and right-branching structures would have the phrasing patterns in (23).

- (23) a. [[[A] B] C] → (A) (B) (C)  
 b. [A [B [C]]] → (A) (B) (C)

(23a) violates No Post-Focus Phrasing. For example, consider a left-branching compound and a right-branching phrase with emphatic stress.

- (24) a. [[[**waste**] disposal] plan] → \* (waste) (disposal) (plan)  
 b. [Alice [loves [**hamsters**]]] → (Alice) (loves) (**hamsters**)

The alternative phrasing in (25a) also violates the principle of increasing units as well as No Post-Focus Phrasing.

- (25) a. [[[A] B] C] → (A B) (C) \* (waste disposal) (plan)  
 b. [A [B [C]]] → (A) (B C) (Alice) (loves **hamsters**)

Thus, it is preferable not to implement prosodic boundaries in left-branching structure in phonetic output, as shown in (26a).

- (26) a. [[[A] B] C] → (A B C) (**waste disposal plan**)  
 b. [A [B [C]]] → (A B C) (Alice loves **hamsters**)

(26a) violates neither No Post-Focus Phrasing nor the principle of increasing units. Thus, the no-boundary pattern (26a) is the only acceptable phrasing for left-branching structure, while (24b), (25b) and (26b) are all acceptable for right-branching structure. This difference gives rise to the junctural asymmetry between left-branching and right-branching structure.

### 3. Deriving Head Directionality from Junctural Asymmetry

#### 3.1. The Head Parameter

In this section, I argue that junctural asymmetry leads to the elimination of the head (directionality) parameter. In principles and parameters theory (Chomsky (1981)), the head-complement order is decided by setting the value of the head parameter as head-initial or head-final. However, the idea of the head parameter has conceptual and empirical problems in the minimalist framework. First, the status of the head parameter is not clear if we assume that syntax is order-free. If we assume the LCA, which states that the base order is head-complement only, the difference in head-complement orders between languages is ascribed to the possibility of complement movement to the specifier position. The problem is then what determines the possibility of the movement.

Second, the head parameter struggles to explain the fact that a number of languages have inconsistent head-complement orders. Huang (1994) observes that Chinese has head-initial order in VP and PP but head-final order in NP. Tokizaki and Kuwana (to appear b) show that most languages have different head-complement orders in different morphosyntactic categories. Following Dryer (1992), I define “head” as a non-branching category and “complement” as a (potentially) branching category.<sup>4</sup> I call a category “branching” if it is made by merging two syntactic objects, including affixes. Then, an affix is the head of a word because it is non-branching; the stem is the complement of the affix because it is potentially branching (e.g. [<sub>Stem</sub> *friend*]-s; [<sub>Stem</sub> *friend-ship*]-s).<sup>5</sup> Similarly, a genitive phrase is the complement of the head noun (e.g. [<sub>Gen</sub> *the girl's*] *cat*; *owner* [<sub>Gen</sub> *of the car*]).<sup>6</sup> For example, Romance languages have head-final order in Stem-Affix, and head-initial order in Noun-Genitive, Adposition-NP, V-O and C-IP; Germanic languages have head-final order in Stem-Affix and Genitive-Noun, and head-initial order in Adposition-NP, V-O and C-IP.<sup>7</sup> Then, setting a value of the head-parameter as head-initial/final is not

enough to derive all the head-complement orders in languages other than consistent head-initial/final languages such as Swahili/Japanese (also called harmonic languages). In fact, as I have just claimed with regard to Romance and Germanic languages, most languages in the world are disharmonic in their head-complement order. On the other hand, we would miss a generalization if we were to conclude that each syntactic category has its own head parameter value in a language. Greenberg (1963), Hawkins (1983) and Dryer (1992) have observed implicational relations between head-complement orders in languages of the world. For example, Greenberg's (1963) universal number 4 states that with overwhelmingly greater than chance frequency, languages with normal SOV order are postpositional [SOV  $\rightarrow$  NP-P]. Greenberg's other implicational universals include [NP-P  $\rightarrow$  Gen-N], [Prefix-Stem  $\rightarrow$  P-NP] and [IP-Question Particle  $\rightarrow$  NP-P]. We need to explain these implicational universals about head-complement orders in a principled way.

The problem of disharmonic head-complement orders is critical in language acquisition. It has been argued that the acquisition of parameters is rapid and error-free. According to Radford (1990), children of 18 months old set the head-parameter of English as head-initial from the earliest multiword utterances. However, English is not consistently head-initial across morphosyntactic categories, as we have seen. English-speaking children must set the head-parameter value as head-final for word and NP, and head-initial for the other syntactic categories.<sup>8</sup> The acquisition problem becomes more serious when we consider the variety of disharmonic word orders in the world's languages.

Thus, we should not include a set of "head parameters" in grammar. In the following sections, I argue that linear orders between heads and complements are determined by the stress constraint on complement movement.

### 3.2. Cyclic Complement Movement

Kayne (1994) argues that head-final orders are derived from the universal base order specifier-head-complement by movement of the complement to a specifier position of the head (or of a higher functional head associated with it). For example, PPs may surface as the base P-NP order or as the NP-P order derived by movement of NP to the Spec of P. The difference of head-complement orders is attributed to the possibility of complement movement in languages. Then, linear information such as head-complement orders is not necessary in morphosyntax. However, the question still remains as to what kind of condition determines the applicability of complement movement. In the next section I will give an answer to this question in terms of the junctural asymmetry between left-branching and right-branching structure that was presented in section 2.

Assuming the universal base order specifier-head-complement, I argue that complement-head orders are derived by cyclic movement of complement into a specifier position of the head (or a higher functional head associated with it): Stem-Affix, Genitive-Noun, NP-Adposition, O-V and IP-C are derived from the base orders by complement movement. Complement movement recursively applies to the structure resulting from the preceding movement. This roll-up (or snowballing) nature of the movement is supported by the fact that a language has head-final order in smaller morphosyntactic categories and head-initial order in larger categories, as we have seen in the Romance and Germanic word orders.

Biberauer et al. (2008) argue that complement movement applies cyclically to derive possible head-complement orders in VP, vP, TP and CP (and possibly words and compounds). I argue that this idea of roll-up movement can be extended to all morphosyntactic categories from words to clauses. A hierarchy of categories relevant for the discussion is shown in (27).<sup>9</sup>

- (27) CP (C-IP) > VP (V-PP) > PP (P-NP) > NP (N-Genitive) > word  
(Affix-Stem)

This hierarchy is determined by the minimal structure of each category. PP (P-NP) dominates NP (N-Genitive) in (27) because PP must immediately dominate NP as the complement (e.g. *of physics*) while NP need not take PP as its complement (e.g. *common knowledge*).

Cyclic complement movement applies to the base structure in (28a) to derive the structures in (28b-f).

- (28) a. [CP C [IP ... [VP V [PP P [NP N [Genitive Affix Stem]]]]]]]  
 b. [CP C [IP ... [VP V [PP P [NP N [Genitive Stem Affix]]]]]]]  
 c. [CP C [IP ... [VP V [PP P [NP [Genitive Stem Affix] N]]]]]]]  
 d. [CP C [IP ... [VP V [PP [NP [Genitive Stem Affix] N] P]]]]]  
 e. [CP C [IP ... [VP [PP [NP [Genitive Stem Affix] N] P] V]]]  
 f. [CP [IP ... [VP [PP [NP [Genitive Stem Affix] N] P] V]] C]

A part of these structures is linearized into complement-head orders: Stem-Affix (28b), Genitive-Noun (28c), NP-P (28d), PP-V (28e) and IP-C (28f). Languages may stop complement movement at a particular step between (28a) and (28f). For example, Bantu languages such as Swahili and Chichewa have a consistent head-initial order (28a). The examples in (29) show that these languages have affix-stem order (Mchombo (2004: 113)).

- (29) a. *m-wia* (Swahili)  
 person-debt  
 ‘debtor’  
 b. *m-sunga* (Chichewa)  
 person-keep  
 ‘keeper’

(28b) is illustrated by, for example, Romance languages, which have complement-head order in the word and head-complement orders in the other categories. For example, French is strongly suffixing and has noun-genitive order, as shown in (30).

- (30) a. *envoy-eur*  
 send-er  
 ‘sender’
- b. *le bras de Jean*  
 the arm of Jean  
 ‘Jean’s arm’

English has the word order in (28c). Complement movement applies to Stem and then to Genitive, giving Stem-Affix (e.g. *stabiliz-ation*) and Genitive-Noun order (e.g. *girls’ school*).<sup>10</sup> In PP, VP and CP, the complement stays in the base position, giving the head-initial orders in these phrases (e.g. *to church*; *eat lunch*; *before you go*).<sup>11</sup> (28d) is illustrated by some Finnic languages. Finnish has postpositions and VO order, as shown in (31).

- (31) a. *pöydän alla*  
 table below  
 ‘under the table’
- b. *Koira puri miestä*  
 dog bit man  
 ‘The dog bit the man.’

(28e) is illustrated by some Indic languages such as Hindi and Urdu, which have OV and adverbial subordinator-clause order.

- (32) a. *śīla-ne dūd’ piya.*  
 Sheila-Agent milk drank

‘Sheila drank the milk.’

(Kachru (2009: 412))

b. *jab vah āega to main jāūṁgā*

when he come then I go

‘When he comes, I’ll go.’

(McGregor (1972: 125))

Japanese has total roll-up movement to give the consistent head-final order (28f), as shown in (33).

(33) a. *kodomo-tachi*

child-Pl

‘children’

b. *anata-ga iku maeni*

you-Nom go before

‘before you go’

All the word orders in (28) are predicted to exist in the world’s languages. This prediction is borne out. The categories in (27) correspond to the word order data in Dryer (2005a, b, c, d, e) shown in (34), where numbers in square brackets show the feature numbers in Haspelmath et al. (2005).<sup>12</sup>

(34) a. CP (C-IP): Order of Adverbial Subordinator and Clause [94]

b. VP (V-PP): Order of Object and Verb [83]

c. PP (P-NP): Order of Adposition and Noun Phrase NP [85]

d. NP (N-Genitive): Order of Genitive and Noun [86]

e. word (Affix-Stem): Prefixing vs. Suffixing in Inflectional Morphology [26]

In (34b), I assume that O-V is a case of PP-V when P is not present, as in the English accusative. These data show that the word orders in (28a-f) correspond to languages in the genera in (35a-f), respectively.<sup>13</sup>

- (35) a. Bantoid, Berber, Biu-Mandara, Cayuvava, Chinantecan, Cross River,  
Egyptian-Coptic, Huavean, Mayan, Mixtecan, Nilotic, Oceanic,  
Otomian, Palauan, Platoid, South Mindanao, Southern Philippines,  
Sulawesi, Sundic, Ubangi
- b. Albanian, Biu-Mandara, Bongo-Bagirmi, Celtic, Central Salish, East Chadic,  
Greek, Laal, Mayan, Nicobarese, Nilotic, Northern Atlantic, Oceanic,  
Platoid, Romance, Semitic, Slavic, Sundic, Surmic, Tsimshianic,  
West Chadic, Yapese
- c. Baltic, Garrwan, Germanic, Indic
- d. Finnic
- e. Armenian, Binanderean, Gur, Indic, Kartvelian, Northern  
Chukotko-Kamchatkan, Nyimang, Turkic, Western Mande
- f. Awju-Dumut, Basque, Cariban, Central Khoisan, Korean, Chitimacha,  
Dogon, Engan, Finnic, Haida, Huitoto, Indic, Japanese,  
Kuki-Chin-Naga, Madang, Mirish, Mongolic, Misumalpan, Munda, Ram,  
Semitic, South-Central Dravidian, Tacanan, Turkic, Yanomam, Yukaghir

The existence of these genera supports the idea of cyclic complement movement.

### 3.3. The Stress Constraint on Complement Movement

In order to account for word order variation among languages, we need to know what stops cyclic complement movement at a particular step in the derivation. In this section, I argue that word-stress location functions as the constraint on complement movement.

In section 2.1, I argued that complement movement changes right-branching structure into left-branching structure at PF. In the resulting structure, the main stress falls on the leftmost element, which is the most deeply embedded element, as shown in (36b-d).



- (36) a. [H3P H3 [H2P H2 [H1P H1 **Compl**]]]  
 b. [H3P H3 [H2P H2 [H1P **Compl** H1]]]  
 c. [H3P H3 [H2P [H1P **Compl** H1] H2]]  
 d. [H3P [H2P [H1P **Compl** H1] H2] H3]

Recall that left-branching structure has strong juncture between its immediate constituents and behaves as a (quasi-)compound. Then, left-branching structure must have the same stress location as a word or a compound in the language.<sup>14</sup> Complement movement is allowed only if the resulting structure has the same stress location as a word in the language. Let us assume the simplest case where each head consists of one syllable in (36). The first complement movement applies to (36a) to give the quasi-compound H<sub>1</sub>P in (36b) only if penultimate stress is allowed in the language. Similarly, the second movement may apply to give (36c) only if antepenultimate stress is allowed. (36d) is possible in languages with initial stress but not in languages with righthand stress.

For example, English has right-oriented word stress, which allows antepenult, penult and ultimate stress (Goedemans and van der Hulst (2005b)). Complement movement derives Stem-Affix and Genitive-Noun order without violating the stress constraint, as shown in (37) and (38).

- (37) a. [N [Aff -er] [V **buy**]]  
 b. [N [V **buy**] [Aff -er]]  
 (38) a. [NP strike [Gen [[V **buy**] [Aff -er]]'s]]  
 b. [NP [Gen [[V **buy**] [Aff -er]]'s] strike]

In the word (37b) and the NP (38b), stress falls on the penult and the antepenult respectively, which is allowed in a right-oriented stress system.<sup>15, 16</sup> However, if an adposition is merged with the NP in (38b), complement movement would result in unacceptable stress-location, as shown in (39b).

- (39) a. [PP on [NP [Gen [[V **buy**] [Aff -er]]'s] strike]]  
 b. \*[PP [NP [Gen [[V **buy**] [Aff -er]]'s] strike] on]

In the postpositional phrase (39b), stress falls on the pre-antepenultimate syllable, violating the constraint on stress location in left-branching (quasi-)compounds. Thus, English stays at the prepositional phrase step as in (39a). Similarly, verb-object and adverbial subordinator-clause have head-initial orders in English.

Thus, we expect that languages may allow different complement-head orders according to their stress location. Initial-stress languages allow postposition in (39b), OV and IP-C. Penultimate-stress languages allow stem-suffix in (37b) but not Genitive-Noun order in (38b), which has antepenult stress, nor postposition in (39b). See Tokizaki and Kuwana (to appear b) for the details of this analysis. We can formulate the function of word-stress as the stress constraint on complement movement as in (40).

- (40) Complement moves to the specifier position of its head (or a higher functional head) only if the resulting left-branching structure has the same stress location as the words in the language.

Note that this constraint applies not to each lexical item or phrase but to each syntactic category in general such as word and VP. I will return to this matter in section 3.5.

### 3.4. A Statistical Analysis of Data in WALS

The stress constraint on complement movement is supported by the data in Goedemans and van der Hulst (2005a, b) and Dryer (2005a, b, c, d, e) included in WALS. Here I present a summary of the statistical analysis in Tokizaki and Fukuda (2011).

Goedemans and van der Hulst (2005a, b) classify the stress systems of the world's languages into fixed stress and weight-sensitive stress, as shown in (41).

- (41) a. Fixed stress: initial, second, third, antipenult, penult, ultimate, ...

- b. Weight-sensitive stress: left-edge (initial or second), left-oriented (initial second or third), right-oriented (antepenult, penult or ultimate), right-edge (penult or ultimate), unbounded, ...

In a weight-sensitive stress system, stress location changes according to the syllable weight. Note that the classification in (41) does not include a lexical stress system (cf. Goedemans (2010)). Note also that different stress locations according to parts of speech are not discussed in Goedemans and van der Hulst (2005a, b). However, so-called ‘lefthand stress’ in nouns and ‘righthand stress’ in verbs in English can be subsumed into right-oriented stress, which covers antepenult, penult and ultimate stress.<sup>17</sup>

The data of stress location in (41) and word orders in (34) were downloaded from the online version of WALS (<http://www.wals.info>) and converted into a spreadsheet file. The numbers of genera instead of languages were counted manually. The result is shown in Table 1, where fixed-stress locations and weight-sensitive stress locations are ordered from left to right.

Table 1: Numbers of genera classified by stress location and head-complement orders

Genera	Initial	Penult	Ultimate	L-ed	Unbnd	R-ori	R-ed	Total
Aff-Stem	6	9	3	0	4	2	2	26
Stem-Aff	23	19	13	14	15	6	10	100
N-Gen	7	15	13	0	7	5	7	54
Gen-N	27	16	14	12	18	5	11	103
P-NP	12	18	14	1	8	5	9	67
NP-P	22	11	12	9	13	6	10	83
VO	17	21	14	4	10	5	8	79
OV	25	14	14	14	12	6	10	95
Sub-Cl	15	20	11	1	12	6	12	77
Cl-Sub	3	6	6	4	7	1	2	29
<b>H-C Sum</b>	<b>57</b>	<b>83</b>	<b>55</b>	<b>6</b>	<b>41</b>	<b>23</b>	<b>38</b>	<b>303</b>
<b>C-H Sum</b>	<b>100</b>	<b>66</b>	<b>59</b>	<b>53</b>	<b>65</b>	<b>24</b>	<b>43</b>	<b>410</b>
<b>Total</b>	<b>157</b>	<b>149</b>	<b>114</b>	<b>59</b>	<b>106</b>	<b>47</b>	<b>81</b>	<b>713</b>

The ratio between head-complement orders (the first row in each pair) and complement-head orders (the second row in each pair) is shown in Table 2 below. For example, in the genera with initial stress, six genera have Affix-Stem order ( $6/(6+23) = 20.7\%$ ) and twenty-three genera have Stem-Affix order ( $23/(6+23) = 79.3\%$ ).

Table 2: Percentage of genera classified by stress location and head-complement orders

<b>Genera</b>	<b>Initial</b>	<b>Penult</b>	<b>Ultimate</b>	<b>L-ed</b>	<b>Unbnd</b>	<b>R-ori</b>	<b>R-ed</b>	<b>Total</b>
Aff-Stem	20.7	32.1	18.8	0.0	21.1	25.0	16.7	<b>20.6</b>
Stem-Aff	79.3	67.9	81.3	100.0	78.9	75.0	83.3	<b>79.4</b>
N-Gen	20.6	48.4	48.1	0.0	28.0	50.0	38.9	<b>34.4</b>
Gen-N	79.4	51.6	51.9	100.0	72.0	50.0	61.1	<b>65.6</b>
P-NP	35.3	62.1	53.8	10.0	38.1	45.5	47.4	<b>44.7</b>
NP-P	64.7	37.9	46.2	90.0	61.9	54.5	52.6	<b>55.3</b>
VO	40.5	60.0	50.0	22.2	45.5	45.5	44.4	<b>45.4</b>
OV	59.5	40.0	50.0	77.8	54.5	54.5	55.6	<b>54.6</b>
Sub-Cl	83.3	76.9	64.7	20.0	63.2	85.7	85.7	<b>72.6</b>
Cl-Sub	16.7	23.1	35.3	80.0	36.8	14.3	14.3	<b>27.4</b>
<b>H-C Av</b>	<b>36.3</b>	<b>55.7</b>	<b>48.2</b>	<b>10.2</b>	<b>38.7</b>	<b>48.9</b>	<b>46.9</b>	<b>42.5</b>
<b>C-H Av</b>	<b>63.7</b>	<b>44.3</b>	<b>51.8</b>	<b>89.8</b>	<b>61.3</b>	<b>51.1</b>	<b>53.1</b>	<b>57.5</b>

This chart shows two facts about word orders and stress location. First, the total of each H-C order increases from Affix-Stem (20.6%) to Subordinator-Clause (72.6%); C-H order decreases from Stem-Affix (79.4%) to Clause-Subordinator (27.4%). This trend is confirmed by a Cochran's Q test of 49 genera that have all the data in the five orders (0.1% significant). The decrease of complement-head orders is explained by roll-up complement movement, which starts at affix-stem and stops at a particular step to C-IP, as shown in (28a-f).<sup>18</sup>

Second, stress location correlates with head-complement orders. In fixed-stress languages, initial-stress languages have a larger C-H average (63.7%) than penult-stress

(44.3%) and ultimate stress (51.8%) languages. In weight-sensitive stress languages, the C-H average decreases from left-edge stress languages (89.8%) to right-oriented (51.1%) or right-edge (53.1%) languages. Thus, in general terms, as the stress moves leftward, complement-head orders increase. If we disregard the difference between fixed stress and weight-sensitive stress systems, we can put the stress types in the order of the C-H/H-C ratio as shown in Table 3.

Table 3: Percentage of genera classified by stress location and head-complement orders

Genera	L-ed	Initial	Unbnd	R-ed	Ultimate	R-ori	Penult	Total
H-C Av	10.2	36.3	38.7	46.9	48.2	48.9	55.7	42.5
C-H Av	89.8	63.7	61.3	53.1	51.8	51.1	44.3	57.5

The exact left-to-right order of stress location is shown in Table 4.

Table 4: Percentage of genera ordered by stress location

Genera	Initial	L-ed	Unbnd	R-ori	Penult	R-ed	Ultimate	Total
H-C Av	36.3	10.2	38.7	48.9	55.7	46.9	48.2	42.5
C-H Av	63.7	89.8	61.3	51.1	44.3	53.1	51.8	57.5

There are two possible explanations for the gap between Table 3 and Table 4: the Non-Finality constraint and the number of data points. First, Hyman (1977) observes that a majority of languages avoid ultimate position for stress. Prince and Smolensky (1993: 56) formalize this tendency as a NONFINALITY constraint, which states that no head of PrWd [prosodic word] is final in PrWd. This tendency may contribute to the relatively low

percentages of H-C orders in ultimate stress (48.2%) and right-edge stress (46.9%) languages, which are lower than those in penult stress (55.7%) and right-oriented (48.9%), respectively. Downing (2010) argues for a Non-Finality effect in African languages, most of which have penult stress and H-C orders.

Second, it should be noted that the numbers of genera in the various stress types are different. For example, right-oriented stress is found in 47 genera and left-edge stress in 59 genera. On the other hand, initial-stress and penult-stress are found in 157 and 149 genera, respectively. This may affect the relative order of C-H/H-C percentages. We need to consider how we can make a real comparison between genera with different stress locations.

Despite the gap between Table 3 and Table 4, we can show a general correlation between stress location and head-complement orders. Tokizaki and Fukuda (2011) analyzed the data in Table 1 with the prop.test. The result showed that there is significant correlation between the seven stress locations from left to right in Table 4 and N-Genitive order with  $p\text{-value} = 0.001144$  (0.1% significant). The other H-C orders do not show a significant correlation with the seven stress locations from left to right in Table 4. However, if we categorize the seven stress locations into three groups, lefthand stress (Initial and left-edge), unbounded, and righthand (right-oriented, penult, right-edge and ultimate), a Cochran-Armitage trend test of 49 genera shows a significant correlation between these three-way stress locations and three H-C orders out of five: N-Genitive ( $p = 0.0002423$ , 0.1% significant), P-NP ( $p = 0.00649$ , 1% significant) and V-O ( $p = 0.03824$ , 5% significant). The three-way stress locations do not show a significant correlation with Affix-Stem ( $p = 0.1687$ ) and Adverbial Subordinator-Clause ( $p = 0.3922$ ), which have a universal tendency toward stem-affix order and adverbial subordinator-clause order. We can conclude that stress location generally correlates with head-complement orders. This result supports our analysis with the stress constraint on cyclic complement movement.

### 3.5. Correlation: A Tendency or a Principle?

A natural question to ask is whether the correlation between stress location and head-complement orders is a tendency or a principle.<sup>19</sup> In spite of the statistical significance of the correlation, there are a number of exceptions to the proposed generalization. One might expect that the stress constraint on complement movement would allow no exceptions. However, the system proposed here allows some variability. First, languages generally allow some flexibility in stress location in a fixed stress system as well as a weight-sensitive stress system. For example, penult-stress languages may have antepenult or ultimate stress on a number of words. Second, the number of syllables in a constituent varies depending on the length and the number of elements it contains. Large complements such as VP and IP may well have different lengths, and even a stem can consist of more than one morpheme (e.g. [<sub>Stem</sub> *inter-national*]-ize). Thus, complement-head constituents have a range of possible number of syllables. Third, head-complement order is generally consistent in a category such as VP; it does not change according to the length of each lexical item or phrase. Fourth, exceptions to the system proposed here may be due to historical change and language contact. For example, Buduma (Chadic, Afro-Asiatic), which is a VO language, has postpositions as well as prepositions. This is due to its contact with the neighbor language Kanuri (Western Saharan, Nilo Saharan), which is an OV language with postpositions. Fifth, the available database is not comprehensive in that stress location and word orders are not well documented. Although WALS lists 2561 languages including sign languages, it contains data about stress location from only 502 languages, about affixation from 894 languages, N-Genitive data from 1105 languages, adposition data from 1074, V-O data from 1370, and adverbial subordinator-clause data from 611 languages. Goedemans (2010) himself admits that the Stress Typ database, on which WALS is based, has a number of problems including regional



bias and incorrect data. These factors may obscure the correlation between stress and word orders.

### 3.6. Consequences: Language Acquisition and Language Evolution

The analysis presented here has consequences for language acquisition and language evolution. First, let us consider language acquisition. If head-complement orders are decided by the word-stress location, children can acquire the orders by learning the stress pattern of a word, not by imitating the word orders in different phrases they hear.

Mazuka (1996) proposes that the head parameter is set on the basis of prosodic cues in an intonational phrase (cf. Nespor, Guasti and Christophe (1996)). However, Hirsh-Pasek and Golinkoff (1996) observe that children at the one-word utterance stage rely on word order. Guasti (2002: 102) argues that even before children start combining words, they can detect and use word orders in comprehending multiword utterances. These findings show that parameter setting may start before children use prosodic cues in phrases. Our word-stress account goes well with these findings. Children can acquire the basis of head-complement orders when they learn stress location in words.

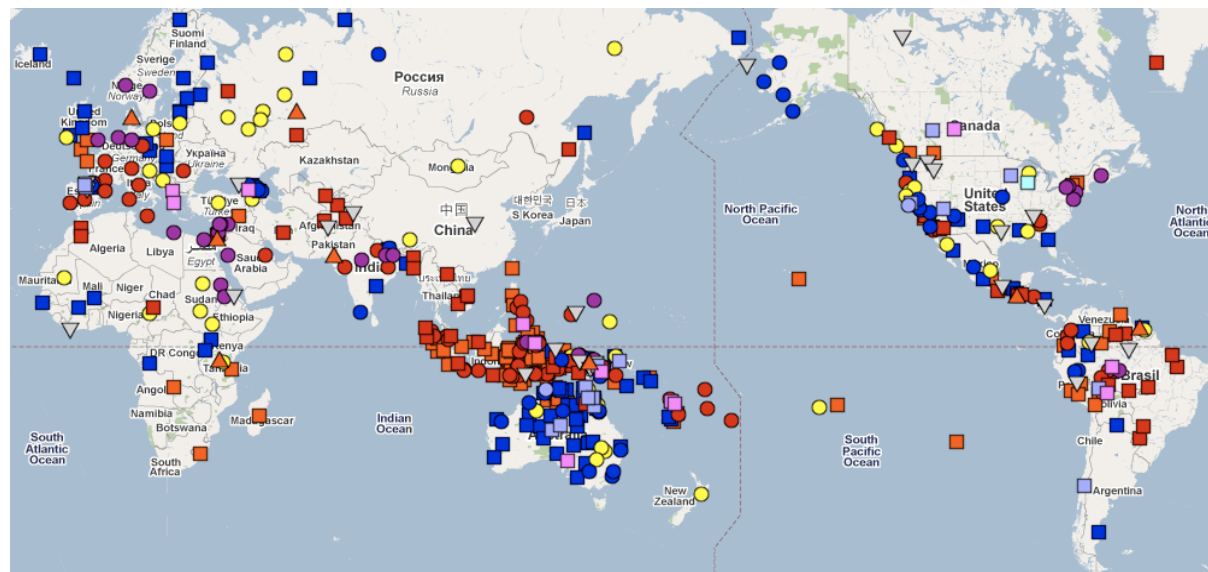
Note that in spite of the stability of word order in children's early English, children can still produce an object-verb order such as *balloon throw* and *book read* (see Radford (1990: 79) and reference cited there). These counterexamples to the head-parameter setting are not problematic to the analysis presented here. Children may well utter VP in different orders (*read bóok/bóok read*) which fit the word-stress location in English (right-oriented) before setting the word order to VP at Verb-Object. Thus, this analysis predicts that children first acquire the word-stress location, which is observed in left-branching structures they try to make. As they learn more words and phrases, they set the word order as head-initial or

head-final for each syntactic category based on their knowledge of stress patterns in the various constructions.<sup>20</sup>

This analysis predicts that languages and dialects in the same language family may have different word orders if they have different stress locations. Donegan and Stampe (1983) show that in Austroasiatic languages, Munda and Mon-Khmer have opposite word orders and stress locations. If we extend stress to other phonological features, Chinese dialects have different numbers of tones and coda consonants (Hashimoto (1978)), which correspond to word order differences (Tokizaki and Kuwana (to appear a)).

Let us turn to a consequence of this analysis for language evolution. The word-stress hypothesis goes well with Bickerton's (1990) idea that languages evolved from protolanguage. At the second stage of language evolution, words are merged to build hierarchical structure. Then, it is plausible that the stress location in one-word utterances is carried over to left-branching compounds and phrases. This analysis also makes it possible to discuss the correlation between stress location or word orders and language expansion from Africa. If we mix the maps of fixed stress and weight-sensitive stress in WALS Online, we get Map 1.

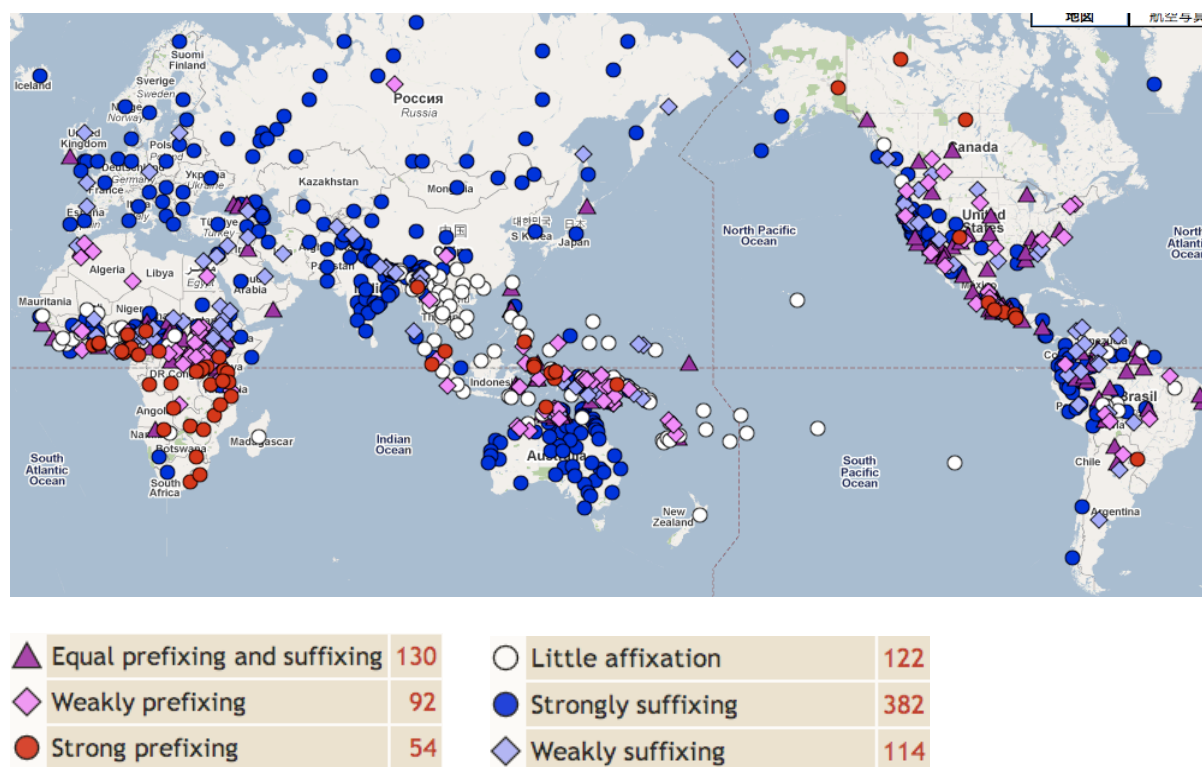
Map 1: Fixed stress and weight-sensitive stress



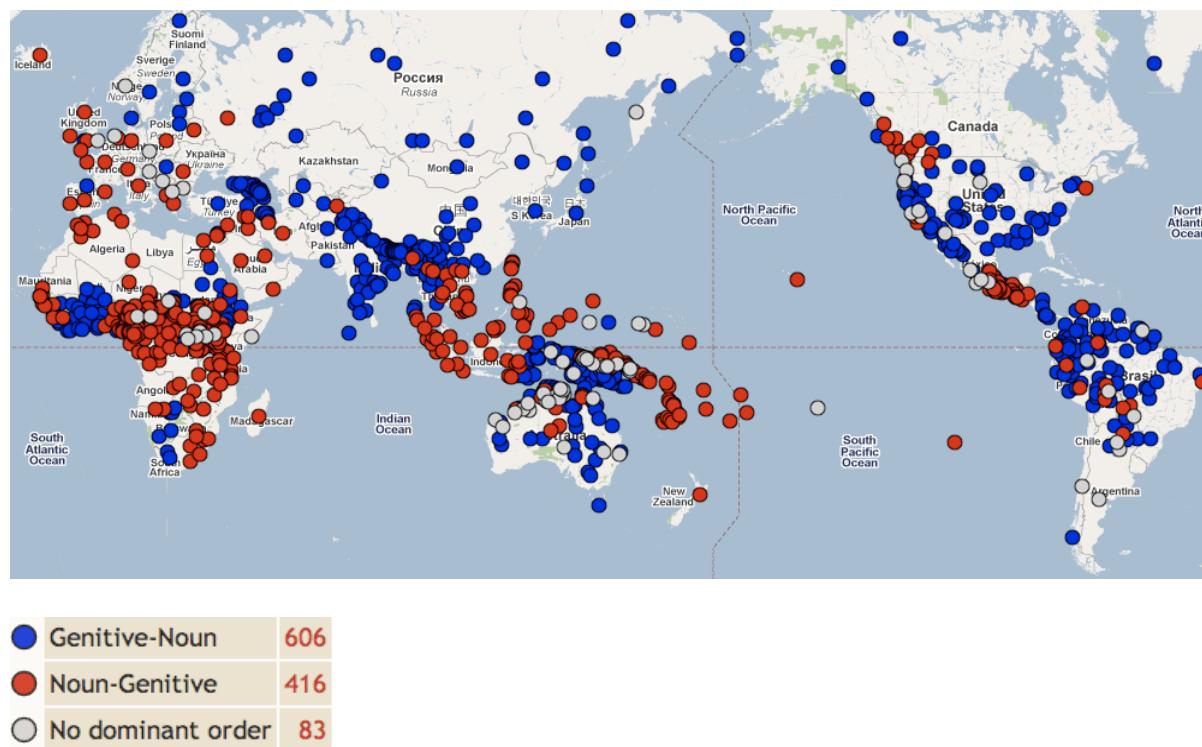
Stress Locations						Weight-Sensitive Stress						
Initial (92)	Second (16)	Third (1)	Antepenultimate (12)	Penultimate (110)	Ultimate (51)	Left- edge: First or second (37)	Left- oriented: One of the first three (2)	Right-edge: Ultimate or penultimate (65)	Right- oriented: One of the last three (27)	Unbounded: Stress can be anywhere (54)	Combined: Right- edge and unbounded (8)	Not predictable (26)
■ 92	■ 16	■ 1	■ 12	■ 110	■ 50	● 37	● 2	● 65	● 27	● 54	▲ 8	▼ 26

Map 1 shows a possible shift in stress location from right to left as language spread from sub-Saharan Africa to the north and east. We can also compare the distribution of head-complement orders shown in Map 2 to Map 6.

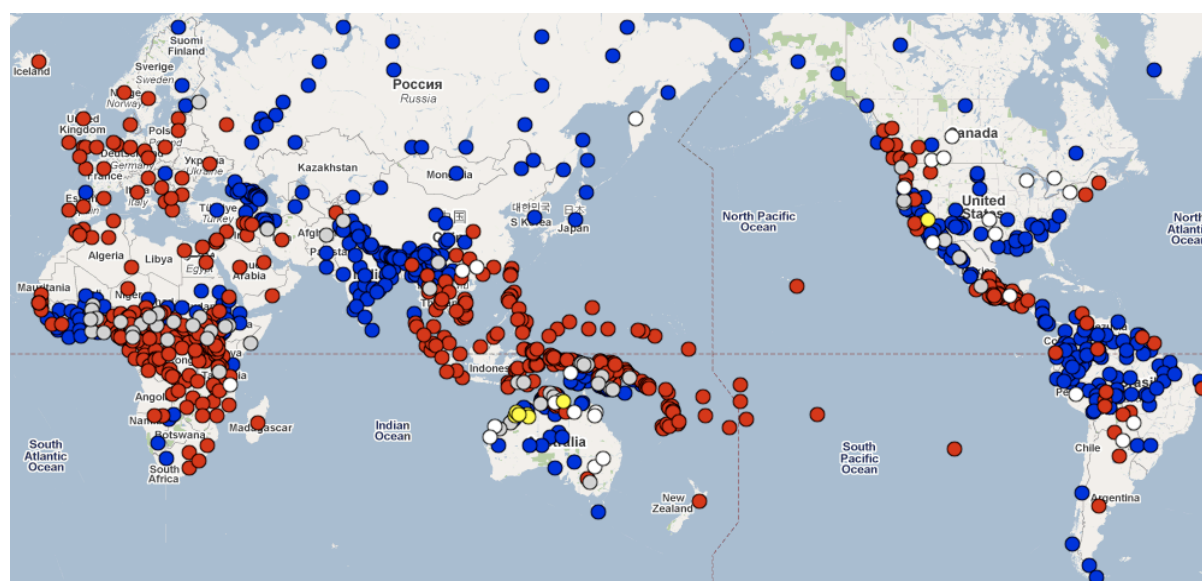
Map 2: Affix-stem orders



Map 3: Noun-genitive orders

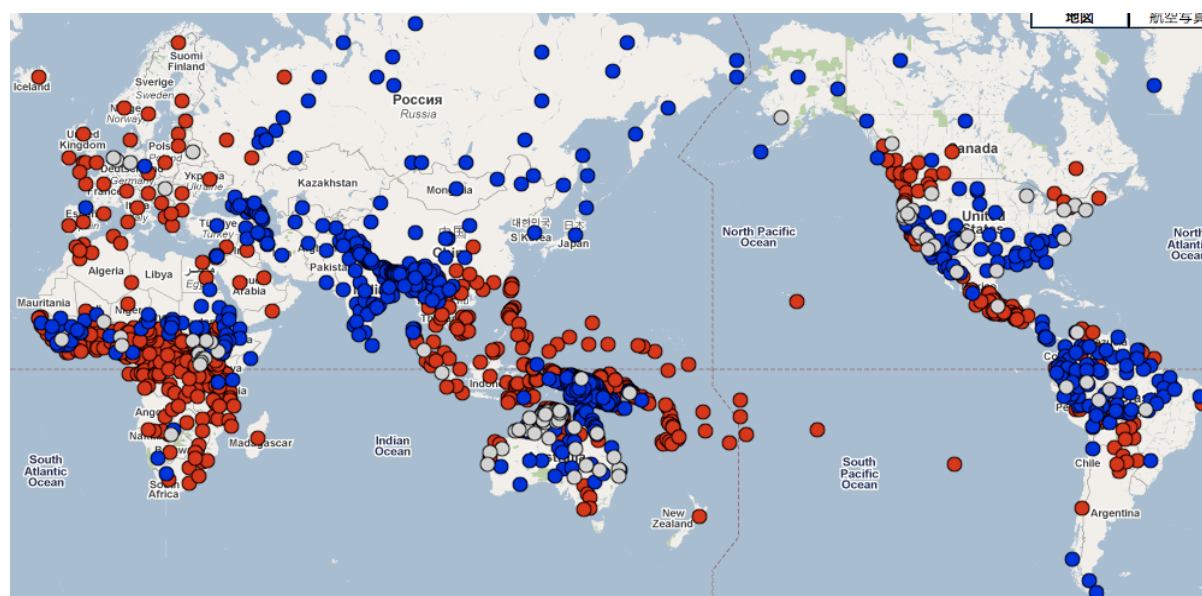


Map 4: Adposition-NP orders



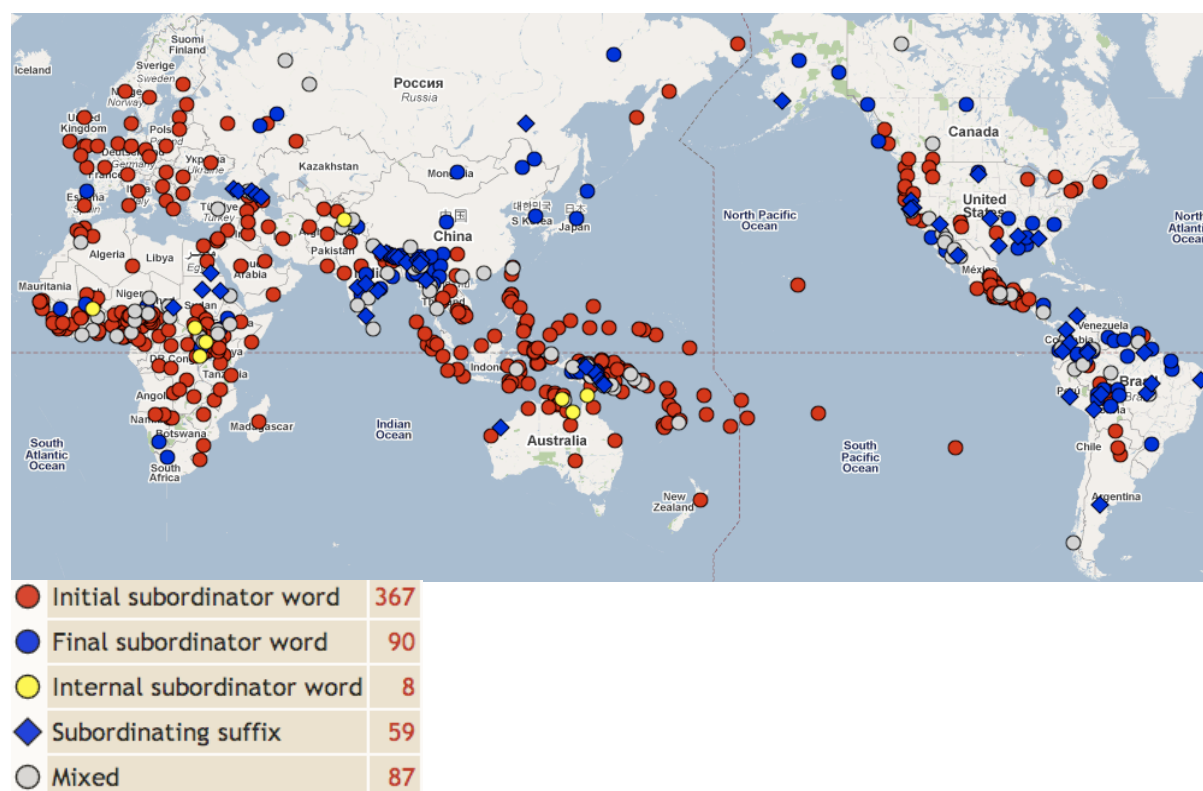
● Postpositions	520
● Prepositions	467
● Inpositions	7
● No dominant order	52
○ No adpositions	28

Map 5: Verb-object orders



● OV	640
● VO	640
○ No dominant order	90

Map 6: Adverbial subordinator-clause orders



Map 2 to Map 6 show that word orders shifted from head-complement (shown in red) to complement-head (shown in blue) when languages spread from sub-Saharan Africa to the north and east. The shift of word orders together with word-stress location is naturally explained by the word-stress constraint on cyclic complement movement.<sup>21</sup> Of course this idea needs to be verified with statistical analysis; I leave this for a future study.

#### 4. Conclusion

To summarize, linear information includes prosodic features such as prominence and juncture, which play crucial roles in encoding and decoding hierarchical structure. I argued that linearization of structure with juncture is asymmetric between left-branching and right-branching structure. Complement movement, which changes a right-branching phrase into a left-branching (quasi-)compound, can apply only if the resulting constituent has the

same stress location as the words in the language. Thus, we can eliminate linear information on head-complement orders from morphosyntax. This is a welcome result in the minimalist program, which restricts linear information to within the interface level of PF.

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## FOOTNOTES

\* Parts of this article were presented at International Phonetics and Phonology Forum (Kobe University, August 2009) and the 28th Conference of the English Linguistic Society of Japan (Nihon University, November 2010). I would like to thank the audiences there for comments and suggestions. I am also indebted to anonymous *EL* reviewers of earlier versions of this article, as well as Yoshihito Dobashi. I also thank Kaoru Fukuda for providing me with statistical analysis of the data. Thanks go to Yasutomo Kuwana for discussion of data and the ideas presented here. This study is supported by Sapporo University and Grant-in-Aid for Scientific Research (A20242010, C22520507). All remaining inadequacies are my own.

<sup>1</sup> A Japanese reviewer comments that he or she does not have the intuition shown in (15) and (16). However, the important point is that we should distinguish stress by intensity and prominence by pitch accent. The first mora in Japanese words has some degree of stress by intensity. This becomes clear when we repeat a word to emphasize it, as shown in (i).

- (i)        *anata-da-yo, anata!*  
              you-is-Part    you  
              ‘You!    It’s you!’

This is clear in a longer example (17) than (15) and (16). Interestingly, Turkish also has word-initial stress characterized by more energy of articulation in addition to pitch accent, which is on the final syllable in most words (Johanson (1998: 34-35), cf. Schiering and van der Hulst (2010: 536) and the references cited therein).

<sup>2</sup> I thank an anonymous reviewer for reminding me of the problems of accent and the compound/phrase distinction in Japanese compounds.

<sup>3</sup> Yamashita and Chang (2001) argue that Japanese has a preference for “long before short”

instead of “short before long” as shown in (21a). However, sentences with a “short before long” order are highly productive in Japanese. For example, sentence (i) is as acceptable as (ii).

- (i) *Mary-ga* [*kinoo* *John-ga* *kekkonshita-to*] *itta*.

Mary-Nom yesterday John-Nom got married-Comp said

‘Mary said that John got married yesterday.’

- (ii) [*Kinoo* *John-ga* *kekkonshita-to*] *Mary-ga* *itta*.

yesterday John-Nom got married-Comp Mary-Nom said

‘Mary said that John got married yesterday.’

The order in (i) becomes more natural when a comma pause is inserted after the matrix subject *Mary-ga* (Tokizaki (2008a: 116)). Note that Ghini’s principle of increasing units applies to phonological phrasing and not to syntactic constituents.

<sup>4</sup> Dryer (1992) uses the terms “verb pattern/object pattern” in place of “head/complement.”

<sup>5</sup> Here I discuss the inflectional affixes considered in Dryer (2005a), which includes four types of affix on nouns (case, plural, pronominal possessive, definite or indefinite) and six types of affix on verbs (pronominal subject, tense-aspect, pronominal object, negative, interrogative, adverbial subordinator). I also consider some derivational affixes such as (29), (30a) and *-ation* in *stabiliz-ation*. Note that the definition of the head of a word here is different from that of Williams (1981), who considers that the head is the constituent that determines the properties of the whole. According to his definition, both [<sub>N</sub> [<sub>V</sub> *construct*] [<sub>N</sub> *ion*]] and [<sub>V</sub> *re* [<sub>V</sub> *construct*]] have a right-hand head. The definition here describes *construct-ion* has a right-hand head while *re-construct* has a left-hand head.

<sup>6</sup> Dryer (2005d) gives examples of genitive and noun in languages other than English, as shown in (i).

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- (i) a. *tyttö-n kissa* (Finnish)  
 girl-Gen cat  
 ‘the girl’s cat’
- b. *níimò má-Kùkkú* (Krongo)  
 mother Gen-Kukku  
 ‘Kukku’s mother’
- c. *le père de Jean* (French)  
 the father of Jean  
 ‘Jean’s father’

<sup>7</sup> Head-complement order can also be defined for compounds based on the non-branching/(potentially) branching distinction. For example, *disposal plan* has complement-head order because the first constituent can be branching as in [*waste disposal*] *plan*. This definition does not apply to paratactic compounds such as *black and white*, whose order is not considered here. I do not discuss the head-complement order in compounds in general because Haspelmath et al. (2005) (*The World Atlas of Language Structures* (WALS)) does not include data about word order in compounds.

<sup>8</sup> In English, NP has head-complement order instead of complement-head, as in Gen-N (e.g. *Mary’s son*) when the head N takes PP or CP as its complement, as in (i).

- (i) a. *students of English linguistics*  
 b. *shirts that you gave Mary*

This is expected from the analysis here. Movement of a long complement to the specifier position would make a long compound (\*[<sub>NP</sub> [<sub>PP</sub> *of* [<sub>NP</sub> *English linguistics*]] *students*]); \*[<sub>NP</sub> [<sub>CP</sub> *that* [<sub>IP</sub> *you* [<sub>VP</sub> *gave Mary*]]] *shirt*]), which would have a pause before N because of the boundaries (cf. Tokizaki (2008a, b)). In other words, this derivation would make a phrase dominated by a compound (Tokizaki and Kuwana (to appear b), cf. No Phrase Constraint

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(Aronoff (1976)), the Head-Final-Filter (Williams (1982)) and the Final-Over-Final Constraint (Biberauer et al. (2008)).

<sup>9</sup> The hierarchy (27) contains only categories and orders that are described in Haspelmath et al. (2005) (cf. (34) below). Thus, IP (I-VP) is omitted, which could be included if Haspelmath et al. (2005) had data about the order of I and VP, e.g. auxiliary and verb.

<sup>10</sup> This does not mean that all NPs are head-final in English. If N has CP as its complement as in [<sub>NP</sub> *fact* [<sub>CP</sub> *that* [<sub>IP</sub> *she lives in Tokyo*], NP is head-initial. This is expected if we assume a stress constraint on complement movement, which prohibits \*<sub>[NP</sub> [<sub>CP</sub> *that* [<sub>IP</sub> *she lives in Tokyo*] *fact*]. Thus, in the clausal complement of N, CP, IP and VP need not be head-final.

<sup>11</sup> A reviewer pointed out that German and Dutch have P-NP and OV as their basic orders, which goes against the order VP (V-PP) > PP (P-NP) in the hierarchy (27) and the derivation (28d). We could suggest an alternative order with PP (P-NP) > VP (V-PP). However, I will assume (27) for the following reasons. First, these languages are classified as having no dominant order in VP in WALS because of the VO order in main clauses. Second, these languages also have a number of postpositions and circumpositions. Third, WALS shows that only 7 genera (including Germanic) have OV and P-NP orders while 22 genera have VO and NP-P orders in (28d). This shows that the former is more exceptional than the latter. Fourth, adpositions are generally shorter than verbs. They may cliticize to the following word without moving its complement NP to its specifier position. Fifth, the ratio of V-O in VP (45.4%) is higher than the ratio of P-NP in PP (44.7%) in Table 2 below.

<sup>12</sup> Adverbial subordinators in (34a) are subordinating conjunctions such as *before* in *before you go*.

<sup>13</sup> Some Germanic languages such as German and Dutch have VO in main clauses and OV in subordinate clauses. This is expected in our analysis based on cyclic complement movement.



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Our analysis also predicts that that there are no languages with OV in main clauses and VO in subordinate clauses (mirror Germanic). As far as I know, this is accurate except that Basque has OV in main clauses and VO in subordinate clauses in cases of emphatic focus. Similarly, Germanic and a number of languages in Africa (e.g. Kisi (Atlantic, Niger-Congo; Guinea)) have OV order in clauses containing auxiliaries, but VO order in clauses lacking an auxiliary (Dryer (2005c)). However, there are no languages with VO in clauses containing auxiliaries and OV in clauses lacking an auxiliary. This can also be explained in our analysis. See the discussion in Tokizaki and Kuwana (to appear c). Note that this cyclic-movement analysis does not lead to the expectation that subordinate clauses may have a different VO/OV order according to the depth of embedding. The head-complement order is decided on the category and the configurational pattern of the construction: if a C takes as its complement an IP dominating OV instead of VO, all Cs must do so. This is the case in German and Dutch.

<sup>14</sup> I follow the typological classification of stress location in Goedemans and van der Hulst (2005a, b). See (41) in section 3.4.

<sup>15</sup> Taylor (1996) analyzes descriptive genitives such as *girl's school* as possessive compounds, which have the same stress pattern as compounds. I thank an anonymous reviewer for pointing this out to me.

<sup>16</sup> If a polysyllabic noun such as *option* occurs in place of *strike* in (38a), the resulting structure of compound movement has stress on the fourth syllable from the right end of the word, i.e. *búyer's option*. However, the vowel in unstressed position (*-tion*) is likely to be reduced and dropped. Then, the stress position in the construction is antepenult, which conforms to English stress location.

<sup>17</sup> The StressTyp database (<http://www.unileiden.net/stresstyp/>), which Goedemans and van der Hulst (2005a, b) rely on, shows examples of English words listed in (i).

(i) o'bey, a'genda, mo'lest, 'discipline, as'tonish, mon'soon, tre'mendous, 'innocent,

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ho 'rizon, 'croco,dile,'ali,bi, 'cinnamon

This list includes verbs, nouns and adjectives, which conform to right-oriented stress.

<sup>18</sup> The percentage of VO in VP (45.4%) is larger than that of P-NP in PP (44.7%) by only 0.7%. This difference is not as wide as the differences between other categories, e.g. Affix-Stem (20.6%) and N-Gen (34.4%). We can ascribe the small difference between VP and PP to the fact that both V and P have NP as their complement. The applicability of the stress constraint on complement movement (40) depends on the length of the complement as well as the head. It is plausible that the sizes of complement in each category (stem in word, genitive in NP, NP in PP, NP in VP, and clause in CP) are reflected in the differences between categories in Table 2. I thank an anonymous reviewer for reminding me of this point.

<sup>19</sup> I thank an anonymous reviewer for raising this question.

<sup>20</sup> I would like to thank an anonymous reviewer for raising question about this matter.

<sup>21</sup> A reviewer commented that even if languages spread from Africa, African languages could have made some changes. A possible hypothesis is that as human beings migrated from Africa, languages gradually shifted their stress location leftward. Another possibility is that the first language with initial stress spread across the world, and then stress location started to shift to the right in Africa; the shift gradually spread to the north and east. However, this topic is far beyond the scope of this paper. For language expansion from Africa, see Atkinson (2011) (cf. Diamond and Bellwood (2003)). For word orders in four language families (Indo-European, Bantu, Uto-Aztecan, Austronesian), see Dunn et al. (2011). For theories of language spread, see Labov (2007).