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Is the Mapping to PHON Complex?

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ABSTRACT. Chomsky, Gallego & Otto (2019) argue that the mapping of syntactic structure to PHON (phonology) is complex compared to mapping to SEM (semantics). This article argues that the mapping of syntactic structure to PHON is not complex because it is governed by specific rules and mechanisms.*

Keywords: interface, prosody, linearization, Externalization, stress

1. The question

The minimalist program of linguistic theory assumes that syntactic structure constructed by the computational system is mapped onto two representations, namely semantic representation and phonological representation. One of the goals of linguistic studies is to clarify the mechanisms of the mappings. Comparing the two interfaces, Chomsky, Gallego & Otto (2019: 12) argue that the mapping to PHON is complex, as shown in (1).

(1) Objects constructed in core syntax must be mapped onto representations that can be accessed by C-I and SM systems: SEM and PHON, respectively. Consequently, there must be an operation TRANSFER that hands constructed objects over to the mapping components. The mapping to PHON is complex, involving the computation of stress and a prosodic contour, "flattening" of the hierarchical structure, etc. .... The mapping to SEM is more direct, given that hierarchical structure is the input to semantic interpretation; ….

In this paper, I argue that the mapping to PHON is systematic although it might be more complex than the mapping to SEM. In section 2, I discuss the computation of stress. Section 3 is devoted to the computation of prosodic contour. In section 4, I discuss how "flattening" of the hierarchical structure is done in the syntax-phonology interface. Section 5 concludes the discussion.

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2. The computation of stress

2.1 Stress the bottom element

In this section, I argue that the computation of stress is governed by some simple rules in the syntax-phonology interface. Firstly, I briefly review Cinque's (1993) null theory of stress assignment based on the depth of embedding. Secondly, I show an alternative mechanism of stress computation based on Merge in the minimalist program.

Cinque (1993) argues that stress is assigned to the most deeply embedded element in a hierarchical structure.

(2) a. [$_{VP}$ [$_{V}$ love] [$_{NP}$ [$_{N}$ músic]]]
b. [$_{N0}$ [$_{NP}$ [$_{N}$ tówel]] [$_{N-1}$ rack]]

In the phrase (2a), stress is assigned to the most deeply embedded element *music*. Similarly, stress is assigned to the bottom element *towel* in the compound (2b). Thus, Cinque's rule successfully generalizes Nuclear Stress Rule and Compound Stress Rule (Chomsky & Halle 1968).

However, the minimalist program of linguistic theory assumes Merge only. It does not allow non-branching nodes such as [$_{NP}$ [$_{N}$ músic]] in (2a) and [$_{NP}$ [$_{N}$ tówel]] in (2b). The X-bar theoretic structures in (2) are those in (3) according to the bare phrase structure in the minimalist syntax.

(3) a. [$_{VP}$ [$_{V}$ love] [$_{N}$ music]]
b. [$_{N}$ [$_{N}$ towel] [$_{N}$ rack]]

Then, two words in (2a) and (2b) are embedded at the same level. Although Cinque's rule is simple and general, we need to reformulate it within the minimalist program.

2.2 Prosodic labeling

I have proposed a Strong/Weak labeling for a pair of syntactic objects (Tokizaki 2018b, 2020), shown in (4).[1]

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[1] The formulation of this rule is slightly different from that in Tokizaki (2018b, 2020), which is shown in (i).

(i) Assign S(trong) to a set and W(eak) to a terminal when they are merged.

The rule in (4) is better than (i) because (4) covers the cases of clash [$_{S}$ set] [$_{S}$ set] and lapse [$_{W}$ terminal] [$_{W}$ terminal], both of which are ruled out in PF.

(4) When two syntactic objects are Merged,

a. assign S(trong) to a set

b. assign W(eak) to a terminal

This Prosodic Labeling applies to both phrases and compounds, as shown in (5).

(5) a. [[$_W$ love] [$_S$ beautiful music]]

b. [[$_S$ kitchen towel] [$_W$ rack]]

In (5a), when a set *beautiful music* merges with a terminal *love*, the former is labeled as S and the latter as W. Similarly, in (5b), when a set *kitchen towel* merges with a terminal *rack*, the former is labeled as S and the latter as W.

Now we need to decide which object gets S in the first merge: *beautiful* vs. *music* in (5a) and *kitchen* vs. *towel* in (5b). The simplest way is to assume that *music* and *towel* are single-membered sets (cf. Kayne 2009, Guimarães 2000). Then, these objects are assigned S by Prosodic Labeling (4).

(6) a. [[$_W$ beautiful] {$_S$ music}]

b. [{$_S$ kitchen} [$_W$ towel]]

These structures are merged with terminals *love* and *rack* to give the structures in (7).

(7) a. [[$_W$ love] [$_S$ [$_W$ beautiful] {$_S$ music}]]

b. [[$_S$ {$_S$ kitchen} [$_W$ towel]] [$_W$ rack]]

Then, the main stress is correctly assigned to the object dominated only by S, i.e. *music* in (7a) and *kitchen* in (7b).

An alternative analysis of the first Merge is to assume that the first set in the derivation is in fact a set consisting of a terminal and its covert complement (ø) (cf. Zwart 2004, 2011, Fortuny 2008).

(8) a. [music ø]

b. [ø kitchen]

The covert complement in (8) could be expressed as in (9).

(9) a. [music *by Bach*]

b. [*home* kitchen]

Thus, we can explain the stress on the first terminal in (8) (cf. Tokizaki 2020).

In this section, we have seen that the computation of stress is done by a rather simple mechanism of prosodic labelling based on the asymmetric Merge.

3. The computation of a prosodic contour

3.1 Match theory

Now let us consider how complex the computation of a prosodic contour is. One of the current theories of prosodic phonology is the Match Theory proposed by Selkirk (2011) and Elfner (2012). This theory assumes the basic correspondence between syntactic categories and prosodic categories as shown in (10).

(10) a. a clause = an intonational phrase (ι)
 b. a phrase = a phonological phrase (φ)
 c. a word = a prosodic word (ω)

Although this looks like a very simple mapping from syntax onto phonology, these correspondence relations are formulated as violable constraints based on Optimality Theory. We need to consider the interaction of constraints including a number of phonological constraints. Thus, according to the Match Theory, the computation of a prosodic contour is quite complex.

3.2 Recursion of prosodic categories

Another factor making the syntax-phonology interface more complex is the alleged recursivity of prosodic categories. Ladd (1996) argues that intonational phrases can be recursive, showing the sentence in (11).

(11) ($_{IntP}$ This is the dog) ($_{IntP}$ that chased the cat) ($_{IntP}$ that killed the rat) ($_{IntP}$ that ate the malt) ($_{IntP1}$ ($_{IntP2}$ that lay in the house) ($_{IntP3}$ that Jack built))

Ladd observes that there is a weaker boundary between *house* and *that*. Thus, he argues that intonational phrases are recursive and that IntP2 and IntP3 are dominated by IntP1 in (11).

Similarly, Wagner (2005) argues that phonological phrases can be recursive, based on his observation of the pause length in multiple coordination. The following examples (12) and (13) are different in both structure and prosody.

(12) a. [Lysander and [Demetrius and Hermia]]
 b. ($_{PhP}$ Lysander and ($_{PhP}$ Demetrius and Hermia))

(13) a. [[Lysander and Demetrius] and Hermia]

b. ($_{\text{PhP}}$ ($_{\text{PhP}}$ Lysander and Demetrius) and Hermia)

Wagner argues that greater lengthening occurs at the end of a more deeply embedded phrase, i.e. between *and* and *Demitrius* in (12) and between *Demitrius* and *and* in (13).

Although these arguments are tenable, we could attribute the prosodic difference to the difference in prosodic boundaries. In other words, the different pause duration is due to the difference in boundary strength, and not to the difference in hierarchy. Moreover, we need to consider what it means to say that an intonation contour or rhythmic pattern is recursive. Intonation and rhythm are linear and "flat." The Strict Layer Hypothesis proposed by Selkirk (1984), which bans recursive prosodic categories, should be respected if we want to limit the overgeneration of phonological mechanisms in order to attain a highly restricted and more plausible grammar.[2] In the next section, I illustrate the Bare Mapping from syntactic structure onto prosody proposed in Tokizaki (1999, 2008), which computes prosodic phrases and prosodic contours in a simple way.

4. "Flattening" of the hierarchical structure

4.1 Phonological boundaries

In this section, I discuss how the hierarchical structure in syntax is flattened in order to be externalized. The approach taken by Chomsky & Halle (1968: 366) is to insert phonological boundaries into derivation, as shown in (14).

(14) The boundary # is automatically inserted at the beginning and end of every string dominated by a major category, i.e., by one of the lexical categories "noun," "verb," "adjective," or by a category such as "sentence," "noun phrase," "verb phrase," which dominates a lexical category.

An example of this boundary insertion is shown in (15).

(15) [$_{\text{S}}$ # [$_{\text{NP}}$ # [$_{\text{D}}$ the] [$_{\text{N}}$ # book #] #] [$_{\text{VP}}$ # was [$_{\text{PP}}$ # [$_{\text{P}}$ in] [$_{\text{NP}}$ # [$_{\text{D}}$ an] [[$_{\text{A}}$ # un [$_{\text{A}}$ # likely #] #] [$_{\text{N}}$ # place #] #] #] #] #]

[2] Of course, we have to consider the recursivity of prosodic words proposed in Ito and Mester (2012), which I will discuss in another paper.

This representation successfully expresses the fact that *book* in the subject is separated from *was* in the predicate while it is close to *the*: the number of boundaries between *book* and *was* is three while that between *book* and *the* is one.

4.2 Syntactic depth

An idea similar to boundary insertion is proposed by Clements (1978: 29), who formulates the strength of juncture as in (16).

(16) The strength of a juncture is expressed as the total number of categorial nodes it dominates (other than itself) along the two paths connecting it with each of the flanking items.

Clements illustrates this algorithm with the example in (17).

(17) a. [$_{\text{S}}$ [$_{\text{NP}}$ [$_{\text{D}}$ the] [$_{\text{N}}$ children]] [$_{\text{VP}}$ [$_{\text{V}}$ play] [$_{\text{PP}}$ [$_{\text{P}}$ in] [$_{\text{NP}}$ [$_{\text{D}}$ the] [$_{\text{N}}$ yard]]]]]
b. The *2* children *4* play *3* in *3* the *2* yard

The numbers in (17b) represent the strength of juncture between words. Note that Clement's 'juncture' is in fact 'disjuncture' if we take juncture as the degree of connection. Then, the number 4 in (17b) successfully explains the fact that *children* and *play* are separated from each other. However, as Clements himself noticed, the algorithm in (16) makes a wrong prediction with the left-branching structure as in (18).

(18) a. [$_{\text{S}}$ [$_{\text{NP}}$ [$_{\text{D}}$ the children]] [$_{\text{VP}}$ [$_{\text{V}}$ play] [$_{\text{PP}}$ [$_{\text{P}}$ in] [$_{\text{NP}}$ [$_{\text{NP}}$ [$_{\text{NP}}$ [$_{\text{D}}$ my] [$_{\text{N}}$ father's]] [aunt's]] [yard]]]]]
b. The children *4* play *3* in *5* my *2* father's *3* aunt's *3* yard

Although the number 5 is the largest in (18b), to make a long pause there, i.e. between *in* and *my* would be unnatural in prosody. In the next section, I propose Bare Mapping, which is similar to Clement's algorithm, and discuss how to solve this problem.

4.3 Bare Mapping

In this section, I illustrate a simple mapping from syntactic structure onto prosody proposed in Tokizaki (1999, 2008). This mapping is dubbed Bare Mapping because it applies to the bare structure without any non-branching projections in the minimalist framework (Chomsky 1995). Let us consider the example in (19), which is represented with a bare phrase structure without any syntactic category labels (cf. Selkirk 1984).

(19) [[[In] [Pakistan]] [[Tuesday] [[is] [[a] [holiday]]]]]

The Bare Mapping from syntactic structure onto prosodic structure proposed is formulated as in (20).

(20) [⋯] → /⋯/

The interface rule in (20) maps the syntactic structure in (19) onto the phonological structure in (21).

(21) /// In // Pakistan //// Tuesday /// is /// a // holiday ////

The basic representation in (21) is changed into (23a), (23b) and (23c) by the boundary deletion rule in (22).

(22) Delete a certain number (*n*) of boundaries in each boundary sequence.

(23) a. // In Pakistan // Tuesday / is / a holiday //// (n = 2, Prosodic Word)
b. / In Pakistan / Tuesday is a holiday /// (n = 3, Phonological/Intonational Phrase)
c. In Pakistan Tuesday is a holiday // (n = 4, Utterance)

The resulting structures in (23) correspond to various levels of prosodic category, i.e. Prosodic Word, Phonological/Intonational Phrase and Utterance. Thus, Bare Mapping with Boundary Deletion restricts the generation of prosodic categories straightforwardly without assuming Selkirk's (1984) Strict Layer Hypothesis, which bans recursion, skipping levels and so on.

Now, we need to consider the problem of left-branching structure we saw in section 4.2. The examples in (17a) and (18a) are analyzed as (24a) and (24b) with bare phrase structure without labels.

(24) a. [[[the] [children]] [[play] [[in] [[the] [yard]]]]]
b. [[[the] [children]] [[play] [[in] [[[[my] [father's]] [aunt's]] [yard]]]]]

These structures are mapped onto the phonological representations in (25).

(25) a. /// The // children //// play /// in /// the // yard /////
b. /// The // children //// play /// in ///// my // father's /// aunt's // yard /////

The boundary deletion rule with n = 3 changes (25) into (26).

(26) a. The children / play in the yard // (n=3)
b. The children / play in // my father's aunt's yard // (n=3)

The representation in (26a) correctly predicts the prosodic phrasing while that in (26b) wrongly predicts a prosodic boundary between *in* and *my*. Even if we apply the deletion rule with n = 4 to (25b), the result is not a natural phrasing as shown in (27).

(27) The children play in / my father's aunt's yard / (n=4)

In order to solve this problem, I propose a mechanism for simplifying left-branching structure (Left-Bracket Cluster Deletion), which is formulated in (28).

(28) [[[--> [[

I assume that the rule (28) recursively applies to the syntactic structure at the syntax-phonology interface. The left-bracket simplification in (28) changes (24b) (repeated here as (29a) into (29b) at the first application and into (29c) at the second application.

(29) a. [[[the] [children]] [[play] [[in] [[[[my] [father's]] [aunt's]] [yard]]]]]
b. [[[the] [children]] [[play] [[in] [[[my] [father's]] [aunt's]] [yard]]]]]
c. [[[the] [children]] [[play] [[in] [[my] [father's]] [aunt's]] [yard]]]]]

Then, (29c) is mapped onto (30).

(30) /// The // children //// play /// in /// my // father's /// aunt's // yard /////

The boundary deletion with n=3 applies to (30) and gives a natural prosody in (31).

(31) The children / play in my father's aunt's yard //

We need to investigate the nature of the left-bracket simplification. I argue that the juncture between sisters in a left-branching constituent is stronger than that in a right-branching structure. In other words, left-branching structure such as *my father's aunt's yard* in (29) is more of a compound than a phrase. I will return to this matter in the next section (cf. Tokizaki 2011 and Tokizaki & Kuwana 2013).

Thus, Bare Mapping, Boundary Deletion and Left-Bracket Cluster Deletion offer a rather simple "Flattening" mechanism of the hierarchical structure.

4.4 Externalization and parsing

In this section, I discuss how syntactic structure is externalized at the syntax-phonology interface. Let us consider the workspace and the derivation in (32).

(32) Syntax: workspace

a. C H1 H2

b. {C H1} H2

c. {{C H1} H2}

First, three syntactic objects are in the workspace as in (32a). Then, the first Merge makes a set {C H1} as in (32b). Next, the second Merge makes another set {{C H1} H2} as in (32c). Suppose that the next head to be Merged with (32c) is a phase head, then Externalization of (32c) occurs as in (33) (head-final) or (34) (head-initial) depending on the phonology of the language. Here I also show the parsing process with an example in the right column. In (33), a hyphen shows that its right object is closely connected to its left object phonologically. In the case of head-initial Externalization (34), the structure is basically right-branching. I assume that the juncture between sisters of a right-branching constituent is weaker than that of a left-branching structure.

(33)		Head-final Externalization	Parsing	
	a.	**C**-H1	{C H1}	[***ki***_mi-to_] ‘you-with’
	b.	**C**-H1-H2	{{C H1} H2}	[[***ki***_mi-to_] _iku_] ‘you-with go’
(34)		Head-initial Externalization	Parsing	
	a.	H2 / H1	H2 {H1	go with
	b.	H2 / H1 **C**	H2 {H1 C}	go [with **you**]
	c.		{H2 {H1 C}}	[go [with **you**]]

Here I argue that stress or strength (shown in bold) works as the bottom-set marker. The speaker puts the stress on the bottom complement, and then the hearers start Merging it with another syntactic object (cf. Tokizaki 2009).

Next, let us consider another derivation shown in (35), where two Merge operations proceed in a parallel fashion.

(35) Syntax: workspace

a. C1 H1 H2 C2 H3 H4

b. {C H1} H2 {C2 H3} H4

c. {{C H1} H2} {{C2 H3} H4}

d. {{{C H1} H2} {{C2 H3} H4}}

At the final step (35d), the set {{C H1} H2} Merges with the set {{C2 H3} H4} to make the whole constituent. In the case of Head-final Externalization of (35), parsing proceeds as in (36).

(36)	Head-final Externalization	Parsing	
a.	**C1**-H1	{C1 H1}	*__u__chino-ko-ga* my-child-Nom
b.	**C1**-H1 H2	{{C1 H1} H2}	*__ki__mi-to iku* you-with go
c.	**C1**-H1-H2 / **C2**	{{C1 H1} H2} {C2	*__u__chino-ko-ga / __ki__mi* my-child-Nom you
c'.*	**C1**-H1-H2-C2	* {{C1 H1} H2} C2}	* *__u__chino-ko-ga kimi* my-child-Nom you

At the Externalization of C2 in (36c), the speaker should make a pause between H2 and C2 and put a stress on C2 in order to inform the hearers that C2 does not Merge with H2 and that C2 is the bottom of a different constituent from the one including H2. If there was no pause between H2 and C2 and no stress on C2, the hearers would wrongly parse the structure as in (36c'). Thus, pause and stress are necessary for the syntax-phonology interface.

In the case of head-initial Externalization of (35), parsing proceeds as in (37).

(37)	Head-initial Externalization	Parsing	
a.	H2 / H1	{H2 {H1	*John / and*
b.	H2 / H1 **C1** /	{H2 {H1 C1}}	*John / and __I__ /*
c.	H2 / H1 **C1** // H4	{H2 {H1 C1}} {H3	*John / and __I__ // go*
c'.*	H2 / H1 C1 H4	* {H2 {H1 H2 H4	**John / and I go*

In (37a), no stress on H2 and H1 and the boundary between H2 and H1 signal that H1 does not Merge with H2. In (37b), C1 is stressed and is followed by a pause. The stress and the pause signal that C1 Merges with H1 (and not with the following object (H4)) to make a set {H1 C1}, which is then Merged with H2. In (37c), H4 does not Merge with the preceding objects because of the boundaries between them. If someone spoke as in the right column in (37c'), which has no stress on C1 and no boundary between C1 and H4, the hearers would wrongly parse the structure as shown in the center column in (37c'). Thus, stress and pause are important in head-initial Externalization as well as in head-final Externalization.

This analysis allows us to propose an alternative model of Externalization. The standard assumption in the minimalist program is that Transfer of a syntactic object to PF occurs at each phase, i.e. vP and CP. However, this phase-based Externalization faces the assembly problem pointed out by Dobashi (2003): the syntactic object Transferred to PF at the first phase vP (i.e. VP) precedes the one Transferred in the second phase CP (i.e. Subj), as shown in (38).

(38) a. [$_{CP}$ C Subj [$_{vP}$ v *VP*]] --> VP
b. [$_{CP}$ C *Subj* [$_{vP}$ *v VP*]] --> Subj v

However, this predicted order [VP Subj v] is wrong.

This assembly problem does not arise in the analysis presented here, which assumes that Transfer sends each syntactic object to PF one by one in the linear order. Let us consider this point by reviewing the derivation and Transfer (Spell-Out) of a constituent consisting of three syntactic objects, H1, H2 and C in head-initial languages (Bottom-up Spell-Out) and in head-final languages (Top-down Spell-Out).

(39)	Syntax	Bottom-up SO	Top-down SO
a.	C H1 H2	**C**	H2
b.	{C H1} H2	**C**-H1	H2 / H1
c.	{{C H1} H2}	**C**-H1-H2	H2 / H1 **C** /

In both Bottom-up Spell-Out and Top-down Spell-Out, each syntactic object can be Transferred to PF before it is Merged with another syntactic object. In this sense, this model has some similarity with the Branch Right structure building proposed by Phillips (1996, 2003) (cf. Shiobara 2010). Hearers start Merge in parsing when they hear the stress. They do not start Merge until they hear the stress.

3.5 Ordering by phonology

Finally, let us consider how syntactic hierarchical structures are linearized for Externalization. Using a metaphor, Uriagereka (1999) argues that Linearization is to lay a Calder's mobile on the ground. Following this metaphor, I argue that Linearization is to lay a Calder's mobile on *the desk*, whose shape has variation (Tokizaki 2018a). More specifically, Linearization is to lay an asymmetric structure on the phonological template of the language, which has variation. I have argued that word-stress location works as a template that decides the head-directionality: left-hand word-stress matches left-hand phrasal stress and head-final order because complement on the left receives the main stress [**C** H]; right-hand word-stress matches right-hand phrasal stress and head-initial order because complement on the right receives the main stress [H **C**]. In this way, a hierarchical structure is linearized into a sequence with an order according to the phonology of the language.

Of course, we need to investigate languages with inconsistent head-directionality. I argue that we can deal with these languages by considering their stress system more carefully. For example, German has head-final order for some heads (V, A and N) and head-initial order for other heads (D, P and C), as shown in (40) and (41).

(40) a. *dass er zu Hause* [[*viele Bücher*] *liest*]
that he to house many books reads
'that he reads many books at home'

b. *weil Günther draußen* [*auf Simon*] *wartet*
because Günther outside on Simon waits
'because Günther waits for Simon outside'

(41) a. <u>*die*</u> *Arbeit*
the work

b. <u>*in*</u> *Frankfurt*

c. *ich glaube,* [<u>*dass*</u> [*Eric heute kommt*]]
I think that Eric today comes
'I think that Eric will come today'

Inaba & Tokizaki (2019) argue that final heads are content words with stress while initial heads are function words without stress, and that both head-final order and head-initial order match the stem-initial stress in German (complement-content word vs. function word-complement).

In contrast, Mandarin Chinese, which also has disharmonic head-directions, has light tone (or neutral tone) as well as four tones. Tokizaki (2014) argues that head-initial phrases (IP, NegP, PP and VP) may have sandhi tone on the head while head-final phrases (AffixP, *de*-P (PP), AspP, Question-particleP) have light tone on the head. The examples are shown in (42) and (43).[3]

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[3] Mandarin Chinese has head-final order for some NP and VP, which I argue have two tonal domains as in (i).

(i) a. [$_{NP}$ modifier *N*] {$_{TD}$ péngyou de} {$_{TD}$ *fángzi*}
friend De('s) house

b. [$_{VP}$ PP *V*] {$_{TD}$ cóng Zhōngguó} {$_{TD}$ *pǎo* lái}
from China come Perf

c. [$_{VP}$ [ba-NP] *V*] {$_{TD}$ bǎ shì} {$_{TD}$ *zuò* hǎo}
Ba thing do well

(42)	a.	[$_{\text{IP}}$ *modal* VP]	déi zǒu	'must go'	< *deǐ* zǒu
	b.	[$_{\text{NegP}}$ *neg* VP]	*méiyóu* xiě	'not write'	< *méiyoǔ* xiě
	c.	[$_{\text{PP}}$ *P* NP]	*wáng* nǎr	'to where'	< *wǎng* nǎr
	d.	[$_{\text{VP}}$ *V* NP]	*mái* jǐu	'buy alcohol'	< *maǐ* jǐu
(43)	a.	[$_{\text{Word}}$ stem *affix*]	péngyou-*men*	'friend-people'	
	b.	[$_{\text{PP}}$ NP *P*]	péngyou *de*	'friend de (friend's)'	
	c.	[$_{\text{AspP}}$ VP *aspect*]	lái *le*	'come perf (came)'	
	d.	[$_{\text{CP}}$ IP *Q*]	nǐ lèi *ma*?	'you tired Q?'	

This is correctly predicted by the analysis presented here. Sandhi tones precede a citation tone, and a head (weak) precedes its complement (strong); a light tone follows citation tones, and a head (weak) follows its complement (strong). In other words, Chinese has head-final order as well as head-initial order because its prosodic system allows a light tone in head-final constituents.

Thus, we can also explain why German and Chinese are disharmonic in head-directions: they have a specific prosody that allows them to Externalize constituents in two ways.

4. Conclusion

In this paper, I have argued that the mapping to PHON is not so complex as Chomsky, Gallego & Otto (2019) claim. Firstly, I illustrated how the computation of stress is done by Prosodic Labeling based on the asymmetric Merge. Secondly, I argued that the computation of prosodic contour is done by Bare Mapping of syntactic structure onto phonology. Thirdly, it was argued that "flattening" of the hierarchical structure is done by Spell-Out with strong/weak juncture. I also argued that the linear order of head and complement is decided by the word-stress location of the language. All these mechanisms are rather simple and

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Note that the head noun *fángzi* in (ia) has two syllables. Note also that the V in this order must have another word following it. A tonal domain (foot) must have more than one syllable in Mandarin Chinese. The unacceptability of (iib) and (iic) supports the analysis that the constituent in (i) has two tonal domains.

(ii) b. *[cóng Zhōngguó] *pǎo* *{$_{\text{TD}}$ *pǎo*}
   from China come

c. *[bǎ shì] zuò *{$_{\text{TD}}$ *zuò*}
   Ba thing do

systematic. If these arguments are on the right track, we cannot say that the mapping to PHON is more complex than the mapping to SEM.

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