The syllabicity constraint in Mandarin and Wenzhounese: An OT-LFG account

Chen Xie
University of Oxford

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Miriam Butt, Jamie Y. Findlay and Ida Toivonen
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Abstract

In Mandarin and Wenzhounese, a syllabicity constraint penalises syntactically well-formed VPs if the VP consists of a disyllabic verb and a monosyllabic object. There is quantitative evidence that the syllabicity constraint is stronger in Mandarin and weaker in Wenzhounese. Grounded on these empirical data, this paper makes three theoretical points. First, this apparently syntax-sensitive constraint can be formalised in a purely phonological way, so both syntax and phonology can remain domain specific. Second, the stronger/weaker effect of the syllabicity constraint requires a gradient view of grammaticality, which can be captured by combining LFG with Stochastic Optimality Theory. Third, optimality-theoretic constraints might violate modularity by simultaneously referring to syntactic and phonological information. I will show that faithfulness constraints of this format do not violate modularity, while markedness constraints of this format does.

1 Introduction

Accumulating evidence from syntax (Almeida 2014; Asudeh 2001; Bresnan 2007; Featherston 2005) and phonology (Féry & Stoel 2006; Ernestus 2011) suggests that grammar is gradient and that linguists who persist on binary grammaticality have "vastly underestimated the human language capacity" (Bresnan 2016: 607).[†] This paper contributes to this ongoing debate by showing that gradience is also required at the syntax-phonology interface, based on data from two varieties of Chinese: Mandarin and Wenzhounese. Mandarin refers to the standardised common language mainly used in China, and Wenzhounese is a southern Wu dialect mainly spoken in the southeast of Zhejiang Province, China (Zhengzhang 2008).

Many Mandarin words have monosyllabic and disyllabic alternatives, the additional syllable of the latter being usually semantically redundant (Huang & Duanmu 2013; Qin & Duanmu 2017). The same holds for Wenzhounese. Table (1) illustrates this word-length alternation in these two varieties of Chinese. Note that Mandarin data are transcribed with *pinyin* and Wenzhounese with IPA, and the dot marks the syllable boundary.

(1)

	'to repair'		'car'	
Syllable count	1	2	1	2
Mandarin	xiū	xiū.lǐ	chē	qì.chē
Wenzhounese	sou	sou.lei	ts^ho	$tɕ^hi.ts^ho$

Given the word-length alternation outlined above, there are four logically possible combinations for the VP 'to repair cars', as exemplified in

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(2). Although all these VPs are syntactically well-formed, Guo (1938), Lü (1963), Feng (1997), and many others have observed that 2+1 VPs (where the verb is disyllabic and the object monosyllabic) are prosodically ill-formed in Mandarin, which leads to their lower acceptability.

(2)

Syllable count	**Mandarin**		**Wenzhounese**	
1+1	xiū	chē	sou	ts^{h}o
1+2	xiū	qì.chē	sou	tɕ^{h}i.ts^{h}o
2+1	xiū.lǐ	chē	sou.lei	ts^{h}o
2+2	xiū.lǐ	qì.chē	sou.lei	tɕ^{h}i.ts^{h}o

In what follows, I will term the prosodic constraint against 2+1 VPs the *syllabicity constraint*. My experiments (Xie to appear) show that the syllabicity constraint is also effective in Wenzhounese, albeit to a lesser degree (Section 2). As such, the syllabicity constraint raises two questions. First, how and why does phonology appear sensitive to syntactic categories like verbs and objects? In LFG terms, does this necessitate a correspondence function that relates verbs and objects to different phonological representations? Second, how does LFG conceptualise the fact that a constraint is *weaker* in one language than in another? These are the topics of Section 3.

An anonymous reviewer asks whether the syllabicity constraint holds in constructions other than verb-object phrases. There is a mirror constraint for nominal compounds in Mandarin (Feng 1997; Qin & Duanmu 2017), such that 2+1 words (e.g., *qì.chē chǎng* 'car factory', where the modifier is disyllabic) are more acceptable than 1+2 words (e.g., **chē gōng.chǎng* 'car factory', where the head noun is disyllabic). Whether Wenzhounese compounds are thus constrained requires further research.

Within the VP domain, it is more difficult to find other constructions that are subject to the syllabicity constraint because adjuncts tend to occur pre-verbally in both varieties (3).

(3) a. Mandarin
wǒ měi-tiān yóu.yǒng (*měi-tiān)
1SG every-day swim
'I swim everyday.'

b. Wenzhounese
ŋ̍ mei-ne jau.joŋ (*mei-ne)
1SG every-day swim
'I swim everyday.'

Wenzhounese, but not Mandarin, does allow a handful of monosyllabic adverbs (e.g., *ɕi* 'first' and *t^{h}jɛ* 'more, further') to occur post-verbally (Bu 2016: 72). These monosyllabic adverbs can follow disyllabic verbs without lowering a sentence's acceptability, but they are irrelevant to the syllabicity constraint because they need to be placed after the perfective marker

(4a) or after the numeral phrase (4b).[1] Put differently, these adverbs are structurally higher than the VP and therefore outside the domain of the syllabicity constraint.

(4) a. ŋ̍ vɔ.kɔ tsəŋ.lei ɦɔ ɕi
1SG room tidy PFV first
'I'll tidy the room first.'

b. ȵi tɕ^{h}i.ts^{h}o sou.lei [sɔ bu]$_{\text{NumP}}$ t^{h}jɛ
2SG car repair three CLF more
'Repair three more cars!'

Nevertheless, the Wenzhounese examples in (5) might reflect the syllabicity constraint, where there is a pre-verbal patient argument and a post-verbal classifier. Although the numeral for 'one' is usually optional (5b), it is obligatory in (5a), presumably to satisfy the disyllabicity requirement.

(5) a. ŋ̍ tɕ^{h}i.ts^{h}o **sou.lei** [*(ʔi) bu]$_{\text{NumP}}$ ɦɔ ba
1SG car repair one CLF PFV SFP
'I have repaired one car.'

b. ŋ̍ tɕ^{h}i.ts^{h}o **sou** [(ʔi) bu]$_{\text{NumP}}$ ɦɔ ba
1SG car repair one CLF PFV SFP

2 The data

Two things about the syllabicity constraint need to be noted before we proceed. First, the syllabicity constraint is local, applying only to objects governed and immediately preceded by the verb (Feng 2003, 2011; Xie to appear). When the object is preposed, e.g., via topicalisation, it is no longer subject to the syllabicity constraint. For example, the Wenzhounese sentences in (6) are equally acceptable, although the former contains a monosyllabic object *ŋo* and the latter a disyllabic object *ŋo-tsz̩* (SFP = sentence-final particle).

(6) a. ŋo ts^{h}əŋ.lei hɛ ba mei a
tooth clean COMPL SFP NEG Q
'Have you finished cleaning the teeth?'

b. ŋo-tsz̩ ts^{h}əŋ.lei hɛ ba mei a
tooth-tooth clean COMPL SFP NEG Q
'Have you finished cleaning the teeth?'

The locality of the syllabicity constraint will be relevant for the analysis in Section 3.1.

[1] See Jiang et al. (2022) for an overview of Chinese numerals and classifiers, whose LFG analysis can be found in Börjars et al. (2018), Börjars & Payne (2021), and Her (2012).

Second, the violation of the syllabicity constraint is alleviated when a word does not have alternating syllabicity (Duanmu et al. 2018; Lü 1963). For example, the monosyllabic noun *shuǐ* 'water' in Mandarin does not have a disyllabic equivalent, so it can follow a disyllabic verb, as in the 2+1 VP *jié.yuē shuǐ* 'save water'.[2] Nevertheless, if a monosyllabic verb is available (e.g., *jié* 'save'), a 1+1 VP would be preferred, which can be confirmed by searching the Center for Chinese Linguistics corpus (Zhan et al. 2019; accessed on 30 September 2023).

(7)

Pattern		Token count
2+1	jié.yuē shuǐ	16
1+1	jié shuǐ	538

The token count of *jié.yuē shuǐ* (2+1) was manually calculated from 75 results. The token count of *jié shuǐ* (1+1) was estimated via the following procedure. First, I randomly selected 200 out of 2,993 results, using the `=rand()` function in MS Excel. Second, I counted the instances of *jié shuǐ* that were VPs, which amounted to 36 (i.e. 18%).[3] Finally, $2993 \times 18\% \approx 538$.

This alleviating effect will be relevant for our interpretation of Duanmu's (2012) corpus study in Section 2.1. It also suggests that, when there is no alternative to a 2+1 VP, the syllabicity constraint must be overriden by a higher constraint to avoid ineffability, i.e., the failure of producing an output given an input (Asudeh 2001; Mohanan & Mohanan 2003).

2.1 Comparing Mandarin with Wenzhounese

Empirical evidence shows that the syllabicity constraint is very robust in Mandarin but less so in Wenzhounese. This section reviews production data from Duanmu (2012) and Xie (to appear).

Duanmu (2012) samples 4,379 tokens of VPs from the Lancaster Corpus of Mandarin Chinese (LCMC; McEnery & Xiao 2004) and finds that the occurrence of 2+1 VPs is exceptionally low. The results, based on Duanmu (2012: ex. (26), (27)), are summarised in (8). We can first compare 2+2 and 1+2 VPs, from which we observe that they have similar frequencies in the corpus. This means that when the object is disyllabic, the verb can freely alternate between its monosyllabic and disyllabic form. In sharp contrast, the frequency difference between 2+2 and 2+1 VPs indicates that when the verb is disyllabic, a monosyllabic object is strongly disfavoured.

[2] Note that /u/ in *shuǐ* is a glide rather than a syllable nucleus, so the word is monosyllabic. See Duanmu (2007: ch. 4) for Chinese syllable structure.

[3] The remaining tokens were likely NPs: they were part of a nominal compound (e.g., *jié.shuǐ lóng.tóu* 'water saving tap'), a complement of a preposition, or coordianted with other NPs.

(8) Token and type counts of VPs in LCMC

Pattern	**Token count**		**Type count**	
1+1	2,749	(62.78%)	1,187	(46.08%)
1+2	838	(19.14%)	703	(27.29%)
2+1	81	(1.85%)	56	(2.17%)
2+2	711	(16.24%)	630	(24.46%)

Duanmu (2012: 104) further observes that 49 out of 56 (87.5%) 2+1 VP types contain a disyllabic verb derived from a monosyllabic verb, and the two verbs are semantically nonequivalent. For instance, a reduplicated disyllabic verb like *xǐ-xi* 'have a wash' encodes the tentative aspect (Liao 2014), which is absent from its monosyllabic base *xǐ* 'wash'. Therefore, it is likely that these derived disyllabic verbs do not have a monosyllabic equivalent, so they may be exempt from the syllabicity constraint, as discussed at the beginning of Section 2. Thus, at most eight 2+1 VP types may count as genuine exceptions to the syllabicity constraint.

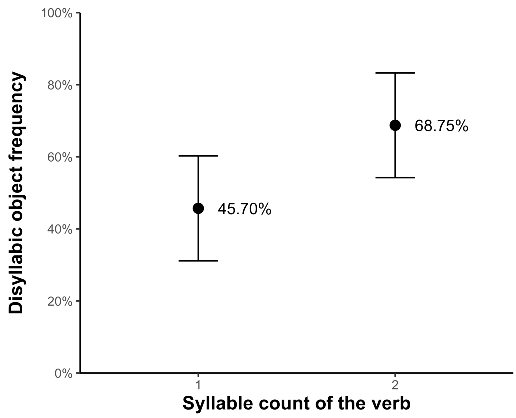


Figure 1: Prediction of the mixed-effects model (fixed effect: syllable count of the verb; random effects: participants and lexical items). The y-axis measures the relative frequency of disyllabic objects, as opposed to monosyllabic objects. The errorbars represent the 95% confidence intervals.

For Wenzhounese, Xie (to appear) reports the results of a production experiment, during which 512 tokens of VPs were collected from 32 native speakers of Wenzhounese. These participants were presented with stimuli containing a non-derived verb followed by a picture and were asked to produce a complete Wenzhounese sentence based on these pieces of information. The syllable count of the verbs was controlled to be monosyllabic or disyllabic, and the pictures corresponded to nouns with mono- and disyllabic alternatives. The results showed that when the verb was monosyllabic, the absolute frequencies for mono- and disyllabic objects were similar (139 and 117, respectively). When the verb was disyllabic, disyllabic objects greatly outnumbered monosyllabic objects (176 vs. 80). This contrast, according to the linear mixed-effects model, was highly significant ($SE = 0.04$, $df = 30.29$, $t = 5.23$, $p < 0.0001$). Figure 1 depicts the prediction of the linear mixed-effects model: when the verb is monosyllabic, the likelihood of producing a disyllabic object is roughly the chance level (45.70%). When the verb is disyllabic, the likelihood of producing a disyllabic object jumps to 68.75%, showing a clear preference for 2+2 VPs over 2+1 VPs.

Based on the Mandarin data in (8) and the Wenzhounese data in Figure 1, we can take 2+1 and 2+2 VPs as minimal pairs and compare their relative frequencies in production. It is clear from Figure 2 that the syllabicity constraint is effective in both varieties because 2+2 VPs are predominant. However, Wenzhounese is more permissive of 2+1 VPs, as indicated by the higher frequency of 2+1 VPs in this variety. This difference suggests that violating the syllabicity constraint is less severe in Wenzhounese. Furthermore, the results of the production experiment are corroborated by the acceptability judgment data, which show that 2+1 VPs are highly unacceptable in Mandarin (Duanmu et al. 2018) but less so in Wenzhounese (Xie to appear).

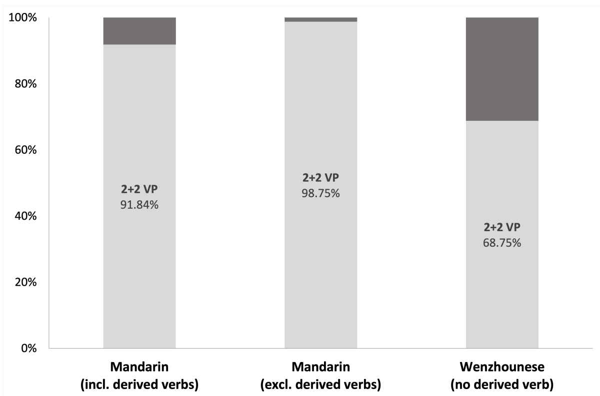


Figure 2: Comparing the production data in Mandarin and Wenzhounese. Each column represents the relative frequency of 2+2 and 2+1 VPs.

The data outlined above are challenging for a theory that assumes binary grammaticality. If such a theory considers 2+1 VPs ungrammatical in Wenzhounese, it cannot explain why the allegedly ungrammatical 2+1 pattern can be produced much more frequently than its Mandarin counterpart. If the theory concludes that 2+1 VPs are grammatical in Wenzhounese, it fails to capture the facts that 2+1 VPs are significantly disfavoured. Therefore, the data support the work by Asudeh (2001), Bresnan et al. (2001, 2007), Bresnan & Nikitina (2009), Clark (2004), Lowe & Belyaev (2015), *inter alia*, who have demonstrated the need to integrate stochastic information into LFG. One way of doing this is to use Stochastic Optimality Theory (SOT), to be discussed in Section 3.2.

3 The analysis

The previous section presents quantitative evidence that the syllabicity constraint is stronger in Mandarin but weaker in Wenzhounese. In Section 3.1, I will argue that the syllabicity constraint results from phrasal stress, whose placement can be captured in a purely phonological way. Therefore, there is no need to posit a direct correspondence between syntax and phonology such that verbs and objects are related to distinct phonological representations. An anonymous reviewer correctly points out that such a direct correspondence is theoretically possible, as LFG by design has a projection architecture that allows different modules to exchange information (e.g., Kaplan 1995), which is also taken up by Butt & King (1998) in their modelling of the syntax-phonology interface. Section 3.3 discusses this possibility, along with potential theoretical issues raised by OT-LFG.

3.1 Phrasal stress

Previous research generally agrees that the syllabicity constraint is subsumed under phrasal stress placement (e.g., Duanmu 2007, 2012; Feng 2011, 2019). According to Duanmu (2007: 146), phrasal stress is assigned as per syntactic configuration:

(9) Non-head stress: In the syntactic structure [X, XP], where X is the syntactic head and XP the non-head, XP should be stressed.

Non-head stress, together with two well-established metrical requirements in (10), can account for the ill-formedness of 2+1 VPs.

(10) Metrical requirements (Duanmu 2012: 106)
   a. Foot binary: A foot needs two syllables, i.e. ($\sigma\sigma$);
   b. Every stress represents a foot.

In a VP, phrasal stress falls on the object as per (9). The stress-bearing object must correspond to a foot (10b), and this foot needs to be disyllabic (10a). Therefore, we can see from (11) that 2+1 VPs have their phrasal stress fallen on the monosyllabic object, which is too small to satisfy (10a).

(11)

Pattern	Metrical structure
1+1	$(\sigma_{\text{verb}}\ \sigma_{\text{object}})$
1+2	$\sigma_{\text{verb}}\ (\sigma\sigma)_{\text{object}}$
2+1	$(\sigma\sigma)_{\text{verb}}\ (\sigma)_{\text{object}}$
2+2	$(\sigma\sigma)_{\text{verb}}\ (\sigma\sigma)_{\text{object}}$

Non-head stress can be readily formalised in LFG by co-description. For example, we can annotate a V′ phrase structure rule with p-structural descriptions such that only the complement of V^0 is specified for phrasal stress, which is not unlike Bögel's (2015: 79) analysis of NP-coordination. However, such an analysis runs counter to the robust generalisation that usually only edge information is relevant at the syntax-phonology interface (Selkirk 1986, 2011). Moreover, non-head stress is empirically flawed: it wrongly predicts that when the object is not local in the VP, it is still subject to the syllabicity constraint (see Section 2 for the locality of this constraint), because a displaced object is still the non-head. These problems can be avoided in the double-tree model (Dalrymple & Mycock 2011; Dalrymple et al. 2019; Mycock 2006; Mycock & Lowe 2013; Tamelan & Arka 2021), whose current version assumes no direct correspondence between c- and p-structure.

In what follows, I propose a strictly modular analysis of the syllabicity constraint via the Indirect Reference approach (Nespor & Vogel 1986; Selkirk 1986). This approach holds that syntax does not have direct access to phonology or *vice versa*. Instead, phonological rules refer to a universal set of prosodic constituents, which are organised into the Prosodic Hierarchy (Selkirk 2011: 437):

(12) Intonational Phrase (ι)
|
Phonological Phrase (φ)
|
Prosodic Word (ω)
|
Foot (Σ)
|
Syllable (σ)

In Mandarin and Wenzhounese, two syllables form a foot (10b). A prosodic word must contain a foot and optionally includes unfooted syllables such as clitics (Anderson 2005; Lahiri & Plank 2022; Spencer & Luis 2012). Higher-level categories can also be defined purely phonologically via phrase structure rules like (13), where A^+ refers to one or more occurrences of A (Partee et al. 1990: sect. 17.2).

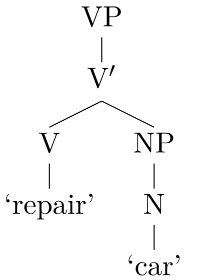
(13) a. $\iota \rightarrow \varphi^+$
b. $\varphi \rightarrow \omega^+$

The edges of prosodic words and higher categories may, but do not have to, align with the edges of syntactic categories (X^0 and XP, respectively). This alignment is known as "Interface Harmony" in LFG, which requires a syntactic label to match a phonological label at the locus of the string (Dalrymple et al. 2019: 417). As Mycock (2023) points out, Interface Harmony may be formalised as optimality-theoretic Align or Match constraints, which are faithfulness constraints calling for correspondence of one or both edges of syntactic and prosodic units (Bellik et al. 2022; Ito & Mester 1999; McCarthy & Prince 1993). For example, Match(XP, φ) requires a syntactic phrase in the input to correspond to a phonological phrase in the output, and Match(X^0, ω) calls for the correspondence between a syntactic word and a prosodic word (Selkirk 2011). Consider the VPs in (14a), all of which instantiate the same c-structure (14b).

(14) a.

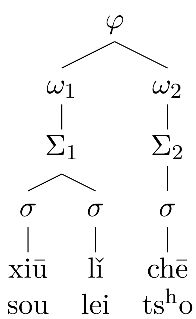
'repair cars'	**2+1**	**2+2**
Mandarin	xiū.lǐ chē	xiū.lǐ qì.chē
Wenzhounese	sou.lei ts^ho	sou.lei $tɕ^hi.ts^ho$

b.

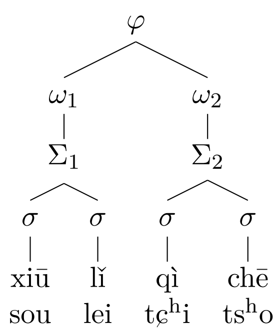


According to the Match constraints, we expect the VP and NP each correspond to a φ in the p-structure, and the V^0 and N^0 each correspond to an ω. Here, I assume that a non-branching φ (i.e. a φ which only dominates one ω) is ruled out on principled grounds (Bennett et al. 2016: 189–190), so the NP in (14b) is realised as an ω in the p-structure below: (15a) is for 2+1 VPs and (15b) for 2+2 VPs.

(15) a.



b.



Since phrasal stress distribution relates to phonology, it should refer to p-structure rather than c-structure to preserve modularity. The generalisation is that phrasal stress falls on the rightmost prosodic word in a phonological phrase, i.e. ω_2 in (15). Since stress must be realised on a binary foot according to (10), we can explain why (15a) is an illegitimate structure: Σ_2 is too small to host stress. Formally, the distribution of phrasal stress can be imposed on (16a) with a template P__STRESS (cf. Dalrymple et al. 2004).

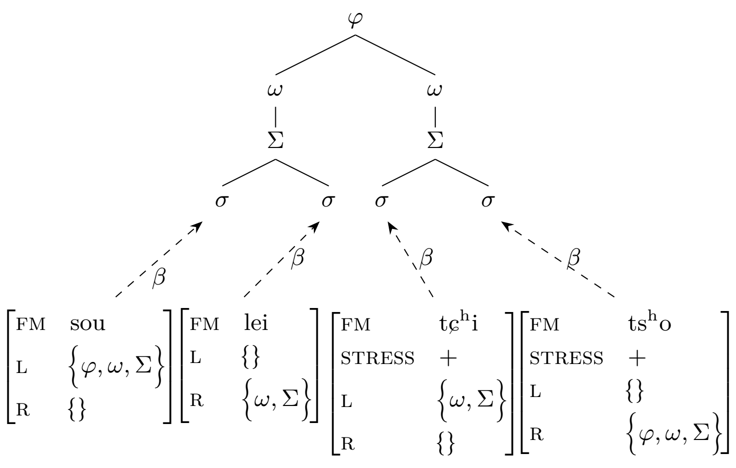
(16) a. $\varphi \quad \rightarrow \quad \omega^{+} \quad \underset{@\text{P\_\_STRESS}}{\omega}$

b. P__STRESS $\equiv$ $D(\diamond) = \Sigma \Rightarrow$
$(\beta^{-1}(T(\diamond))\ \text{STRESS}) = +$

The symbol $\diamond$ refers to a p-structure node (Dalrymple et al. 2019: 415), D is a relation from a node to its daughter nodes, T is a relation from a node to its terminal nodes (see Dalrymple et al. 2019: 413 for a similar function), and β^{-1} is a relation from a p-structure node to a p-string unit. The template P__STRESS annotated under the rightmost ω in (16a) functions as follows. First, the T relation locates all the terminal nodes (i.e. syllables) dominated by this ω and immediately dominated by a foot (Σ).[4] Second, the β^{-1} relation maps these syllables to their corresponding p-string units. Third, the attribute-value pair [STRESS +] is assigned to these p-string units, indicating phrasal stress.

To illustrate, a more articulated p-structure for (15b) is provided in (17), where the p-string units [tɕʰi] and [tsʰo] are mapped to syllables dominated by the rightmost ω. As such, they are specified with [STRESS +], in contrast to the p-string units [sou] and [lei].

(17)



Given the canonical VO order in Mandarin and Wenzhounese, (16a) correctly predicts that phrasal stress by default falls on the object, which

[4] This prevents the illicit assignment of stress to unfooted syllables such as clitics.

sits at the right edge of the φ corresponding to a VP. There is only reference to phonological constituents, not to a syntactic non-head, so (16a) preserves modularity. Moreover, (16a) captures the locality of the syllabicity constraint (Section 2) without further stipulation: an ex-situ object is not final in φ, so it is not the host of phrasal stress. As such, the syllabicity of an ex-situ object is irrelevant to the well-formedness of the p-structure, so an ex-situ object is not subject to the syllabicity constraint (compare (6a) and (6b)).

In short, this section formalises phrasal stress placement in phonology proper. In such a setting, the syllabicity constraint stems from the conflict between phrasal stress and foot binarity: 2+1 VPs can only provide a degenerate foot as the locus of phrasal stress. Although 2+1 VPs have an ill-formed p-structure, they can still be detected in Wenzhounese, suggesting that they are competing with 2+2 VPs. This competition can be captured by the OT-LFG analysis in Section 3.2.[5]

3.2 Stochastic Optimality Theory

Most OT-LFG analyses (e.g., Belyaev 2013; Bresnan 2000, 2002; Lee 2004) take a possibly underspecified f-structure as the input to computation, including Lowe's (2016) analysis of the syntax-phonology interface. However, it is not always appropriate to take f-structure as the input for analysing the syntax-phonology interface, because the relation between f-structure and p-structure is at least mediated by c-structure (see, e.g., Bennett & Elfner 2019; Bögel 2024; Elordieta 2008; Mycock 2015 for overviews), and perhaps by the s-string and p-string (Dalrymple et al. 2019: ch. 11).

To illustrate, the Irish examples in (18) have the same f-structure because the displacement of *leis* 'with him' has no information-structural implication (i.e., there is no additional discourse function in the f-structure), but they do have different p-structures (Bennett et al. 2016: 205).

(18) a. Labharfaidh mé **leis** ar an Chlochán Liath amárach.
speak.FUT I with.him on Dunloe tomorrow
'I'll speak to him tomorrow in Dunloe.'

b. Labharfaidh mé ar an Chlochán Liath amárach **leis**.
speak.FUT I on Dunloe tomorrow with.him
'I'll speak to him tomorrow in Dunloe.'

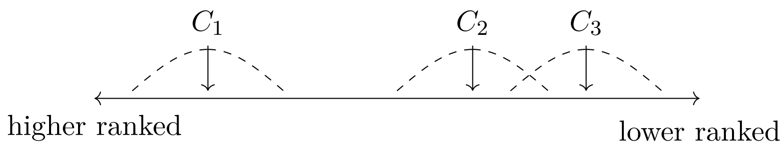
Given that f-structure does not directly encode linear order, no plausible faithfulness constraint can evaluate the correspondence between f-structure and p-structure in cases like (18). Therefore, we need to postulate various input–output relations within LFG's parallel architecture, such as $\alpha \rightarrow \langle \alpha, \beta \rangle$ and $\beta \rightarrow \langle \alpha, \beta \rangle$, where α and β can be any module (Mohanan & Mohanan 2003: 313). For our purpose, (19) would be a feasible relation for

[5] See Dalrymple et al. (2019: 728) and Kuhn (2024) for overviews of OT-LFG.

the syntax-phonology interface (see also Bögel 2015: sect. 4.3.2).

(19) c-structure → ⟨c-structure, p-structure⟩

The rest of this section models the competition between 2+1 and 2+2 VPs with SOT (Boersma 1997; Boersma & Hayes 2001), which differs from standard OT (Prince & Smolensky 2004) in two ways. First, SOT extends constraint dominance $C_1 \gg C_2 \gg C_3$ in standard OT by assigning ranking values r to constraints (Boersma & Hayes 2001: 47–48). Second, at each evaluation, the permanent ranking values may be perturbed by a normally distributed noise. The closer the two constraints, the more likely they are affected by noise, e.g., C_2 and C_3 in (20), where the dashed lines represent noise.

(20)


Unlike standard OT where constraint ordering is fixed in a grammar, constraint ordering in SOT is determined by the disharmonies (*dis*) of constraints (Boersma 1997: 45):

(21) a. $dis = r + rankingSpreading \times z$, where
   (i) r is the ranking value for a constraint,
   (ii) $rankingSpreading = 2$, and
   (iii) z is the noise with mean 0 and standard deviation 1.
 b. $dis_1 - dis_2 = r_1 - r_2 + rankingSpreading \times (z_1 - z_2)$

Even if C_1 has an intrinsically higher ranking value than C_2 (i.e., $r_1 > r_2$), it is possible for C_2 to outrank C_1 at a particular evaluation ($dis_1 - dis_2 < 0$) when C_2 is associated with a large noise ($z_2 > z_1$).

Analysing the syllabicity constraint in Mandarin and Wenzhounese requires the following OT constraints. The alignment constraint (22a) covers the distribution of phrasal stress first set out in (16). The constraints in (22b, c) are equivalent to the metrical requirements for the foot and stress specified in (10). There should also be a lower-ranked constraint that levels against 2+2 VPs, which I assume to be an economy constraint *Struc that favours smaller p-structures than bigger ones.[6]

(22) a. Edgemost-R(Stress, φ): Stress lies at the right edge of the phonological phrase (Prince & Smolensky 2004: 46).

[6]Principles of economy may be decomposed into independently motivated constraints (Dalrymple et al. 2016; Gouskova 2003), which I leave for future research.

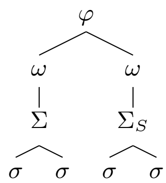
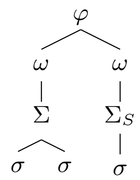
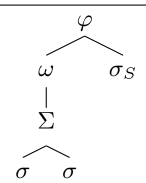
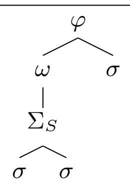
b. FtBin: Feet are binary at some level of analysis (μ, σ) (Prince & Smolensky 2004: 56).
c. Stress→Σ: Stress must be realised on a foot (cf. (10b)).
d. *Struc: For p-structures P_1 and P_2, assign a violation mark to P_1 if it has more nodes than P_2.

For analytical convenience, I only compare 2+2 and 2+1 VPs. Assume that the input to the OT computation is the c-structure $[_{\text{VP}}$ V NP] and the output candidates are p-structures. The ranking in (23) predicts 2+2 VPs to be the optimal candidate.[7]

(23) Constraint ranking
Edgemost-R(Stress, φ) ≫ FtBin; Stress→Σ ≫ *Struc

The competition is demonstrated in Tableau (24), where the subscripted S is shorthand for phrasal stress.

(24)

Input: $[_{\text{VP}}$ V NP]	Edgemost-R	FtBin	Stress→Σ	*Struc
a. 				***
b. 		*!		**
c. 			*!	
d. 	*!			

The p-structures in (24b, c, d) correspond to 2+1 VPs. We can see that (24c, d) have the most economical structure, but (24c) incurs a fatal violation of Stress→Σ because a syllable rather than a foot bears phrasal stress. Stress in (24d) falls on a foot, but this foot is not φ-final, thus violating the undominated Edgemost-R constraint. Although (24b) is more economi-

[7] I do not include Match(XP,φ) here, but it should be undominated in (23).

cal than (24a), it violates the higher-ranked FtBin constraint. As a result, (24a), which corresponds to 2+2 VPs, is the optimal candidate.

In SOT, the default ranking in (23) must be maintained to ensure that both Mandarin and Wenzhounese disfavour 2+1 VPs. The fact that the syllabicity constraint is stronger in Mandarin than in Wenzhounese can be captured by assigning different ranking values to FtBin and *Struc. The ranking value difference, $r_{\text{FtBin}} - r_{*\text{Struc}}$, is much larger in Mandarin than in Wenzhounese, so the situation where $dis_{\text{FtBin}} - dis_{*\text{Struc}} < 0$ (i.e., *Struc outranks FtBin) is less likely to occur in Mandarin than in Wenzhounese. Finally, the ranking value for Edgemost-R(Stress, φ) should be high enough such that it will never be outranked despite the noise. I propose the following ranking values for these constraints:

(25) The ranking values for each constraint

	Edgemost-R	FtBin	Stress→Σ	*Struc
a. Mandarin	80	55	55	50
b. Wenzhounese	80	50.8	50.8	50

Using the `pracma` package (Borchers 2022) in R (R Core Team 2022), we can simulate SOT constraint evaluation (in particular between FtBin and *Struc), which is impacted by a normally distributed noise. For Mandarin, a simulation of (25a) with 100 trials shows that *Struc outranks FtBin only in 2% of the trials, which matches the results demonstrated in the second column of Figure 2.[8] For Wenzhounese, a simulation of (25b) with 100 trials predicts that *Struc outranks FtBin in 30 trials. This is in line with the results demonstrated in the third column of Figure 2, where 2+1 VPs are chosen over 2+2 VPs in 31.25% of the cases.

Note that the juxtaposition of Mandarin and Wenzhounese in (25) does not mean that these languages must be constrained together in the analysis or that candidates generated by the Mandarin grammar would compete with candidates generated by the Wenzhounese grammar. Instead, the relation between (25a) and (25b) is similar to the relation between Lummi and English described in Bresnan et al. (2001), where a constraint is hard in one language and soft in the other. Such a relation is beyond the factorial typology of Standard OT, so it justifies the incorporation of stochastic information into the grammar.

In sum, the simulated data confirm that SOT can successfully generate results that match the frequency of production and correctly capture the difference of the syllabicity constraint in Mandarin and Wenzhounese. In the next section, I discuss theoretical issues raised by an OT-LFG approach to the syntax-phonology interface, given the strict modular view that I adopt.

[8]One can easily simulate the results that include derived disyllabic verbs (the first column of Figure 2) by assigning a smaller ranking value like 53.5 to FtBin. The R codes for simulation are available in the Appendix.

3.3 Modularity and the syntax-phonology interface

My analysis of the syllabicity constraint, which boils down to phrasal stress assignment, assumes a strict version of modularity such that syntax and phonology are incommunicado. The only point of interface is the string, where s-string labels and p-string labels may be required to align as per Interface Harmony (Dalrymple et al. 2019: 417). However, it is important to note that *modules* in LFG are "just units of description" (Kuhn 2007: 614), rather than informationally encapsulated computational systems à la Fodor (1983). This means that an LFG interface does not serve to convert the output of one module to the input of the next module (cf. Jackendoff 2000: 13). In other words, an interface is formally the same as a module, i.e., a set of constraints regulating the representations (Kuhn 2007). Therefore, positing a correspondence function between c-structure and p-structure, as in Bögel (2015) or Butt & King (1998), does not violate modularity from an LFG perspective.

Nevertheless, as LFG has shifted from a syntactic theory to a general grammatical architecture (e.g., Asudeh & Siddiqi 2024), it is necessary to examine whether this projection architecture at the syntax-semantics side could be readily extended to the phonology side. For example, verbal/clausal features like tense and aspect are relevant to syntax for agreement and to semantics for interpretation, and this exchange of information is naturally encoded by the correspondence functions between these modules. By contrast, other than their idiosyncratic association with sound in the lexicon, these features play no role in phonology. This suggests that the modules at the syntax-semantics side are part of a macro-module, to which phonology does not belong. More generally, LFG modules share with Fodorian modules the defining feature of domain specificity, i.e., each module only "responds to stimuli of a particular class" (Coltheart 1999: 118), which prevents tense and aspect from being represented in phonology.[9] This is also why Bögel et al.'s (2009) approach to the syntax-phonology interface must be questioned: they propose to include prosodic boundary information in c-structure, so the resulting representation is no longer domain specific (see Bögel 2024 for further comments on this approach).

Given this strict view that syntax and phonology are incommunicado, one may question the legitimacy of an optimality-theoretic approach to the syntax-phonology interface, because OT's global evaluation potentially allows syntax and phonology to interact (Scheer 2011). I address this concern by discussing first faithfulness constraints and then markedness constraints.

[9]One may wonder if grammatical tones (e.g., Grimm 2023; Sande 2023) undermine domain specificity. They do not, because the association between tones and grammatical features is lexical. For example, a language may encode past tense with a suffix *-ed* or a high tone. The major difference lies in the exponence (segmental vs. suprasegmental), but neither implies that phonology is directly sensitive to syntax.

Faithfulness constraints like ALIGN-L/R(XP,φ) and MATCH(X^0,ω) evaluate to what extent p-structure is isomorphic with c-structure (Section 3.1). According to Scheer (2012: 69), these correspondence constraints are not domain specific because they *convert* syntactic constituency to phonological constituency (emphasis mine). Moreover, the fact that these constraints can be interspersed with purely phonological constraints (e.g., FTBIN in (22b)) means that the intermodular conversion is done in phonology, which destroys the modular architecture (Scheer 2008: 173). Bögel (2015: 193) voices a similar objection against Lowe's (2016) OT-LFG account for endoclisis.[10]

However, the points that Scheer makes are biased because his model of the syntax-phonology interface crucially relies on a Minimalist syntax, where syntax is the sole module with generative power and phonology only interprets information sent from syntax (Newell 2021; Scheer 2023; Heather Newell, p.c.). In such a model, it is natural to speak of *conversion* because prosodic units owe their existence to the correspondence constraints (cf. Selkirk 2009: 40): "prosodic constituency is *first* created by mapping; phonological rules *then* make reference to the prosodic structure" (Scheer 2012: 68).

These Minimalist assumptions do not carry to LFG, where the modules are descriptive, not computational (Kuhn 2007). Therefore, just as f-structure is in no sense derived from c-structure, p-structure is also independent of c-structure (see Wheeldon & Lahiri 2002; Wynne et al. 2018 for psycholinguistic evidence). ALIGN and MATCH constraints should be interpreted as relating pre-established linguistic objects, rather than converting one type of object to another. As such, they are similar to the familiar correspondence functions in LFG's parallel architecture, although ALIGN and MATCH restrict the exchange of information to the edge of syntactic/prosodic categories.[11]

The discussion above establishes the idea that faithfulness constraints, which govern the correspondence between inputs and outputs, can refer to information from different modules without violating domain specificity. By contrast, markedness constraints that refer to both syntactic and phonological information are usually motivated to analyse linguistic phenomena that appear to violate domain specificity. A notable example is category-specific effects, by which words of distinct syntactic categories (typically nouns vs. verbs) have asymmetrical phonological behaviours (Smith 2001, 2011). In some Panoan languages, for instance, underlyingly underspecified

[10] Strictly speaking, this concern does not apply to the double-tree model that Lowe (2016) adopts, because the OTs constraints target *labels* of linguistic objects rather than linguistic objects *per se*. For the sake of generality, the point I make is that, even without labels, correspondence constraints are unproblematic for domain specificity.

[11] We can also compare ALIGN and MATCH constraints to the function $f(x) = 2x$ ($x \in \mathbb{N}$), which establishes the correspondence between a natural number and an even number. Since the output of $f(x)$ is always a natural number, the set of natural numbers $\mathbb{N}$ is closed under f. In the same vein, we can assume that the set of linguistic objects is closed under ALIGN or MATCH, in the sense that these constraints do not create new objects.

consonants occur as coronals when they are part of verbs, and they surface as non-coronals when they are part of nouns or adjectives (Elias-Ulloa 2021). Given that lexical category appears to govern the realisation of these consonants, Elias-Ulloa (2021: 19) proposes to append phonological markedness constraints with syntactic information, partially listed in (26).

(26) a. *Labial]Verb: Assign a violation mark for each labial consonant that occurs at the end of a verb form.
b. *Coronal]Verb: Assign a violation mark for each coronal consonant that occurs at the end of a verb form.

These constraints evaluate verb forms based on their phonological features, so they are not domain specific. Whether such constraints are legitimate depends on the nature of category-specificity.

One possibility is that ostensible category-specific effects do not require phonology to directly refer to syntactic information. Suppose that verbs and nouns are encoded with distinct phonological representations in the lexicon, and it is these phonological representations, rather than lexical categories *per se*, that trigger asymmetrical phonological behaviours (cf. Faust & Scheer 2023; Newell 2021). Under this modularity-preserving view, constraints like (26) are due to misanalysis and should therefore be prohibited. One may ask why verbs and nouns receive different phonological encoding in the first place. A tentative speculation is extra-linguistic force: nouns are less predictable than verbs, especially when the former is a complement of the latter within a VP, which makes nouns more informative than verbs (cf. Shannon 1948), which in turn makes nouns a preferred target for stress (Duanmu 2007: 144; see also non-head stress in (9)). Given the well-established observation that stress prevents lenition (Scheer & Szigetvári 2005), the above speculation naturally explains why nouns are more likely to maintain phonological contrasts and resist phonological neutralisation than verbs are (Smith 2001).

Another possibility is that category-specific effects are real, in the sense that at least some data defy fully domain-specific analyses. In this scenario, constraints like (26) are necessary and the strict modular view that this paper adopts needs to be relaxed. However, it is curious that phonology only refers to major lexical categories and perhaps also the argument-adjunct distinction (Chen 1987), but never to syntactic information like raising verbs (say *Labial]RaisingVerb) or intermediate projections X′, which is theoretically possible. This implies that domain specificity is the norm (as envisaged in the double-tree model) but might be violated in a limited way, which calls for domain-general markedness constraints in OT-LFG. Even under this possibility, we need to note that modularity violation is not due to OT's global computational system, but to markedness constraints that refer to multi-modular information.

4 Conclusion

In Mandarin and Wenzhounese, a syllabicity constraint penalises syntactically well-formed 2+1 VPs. Although this constraint appears sensitive to the distinction between verbhood and objecthood, I have shown in Section 3.1 that a purely phonological analysis is possible and empirically desirable. One aspect that standard LFG cannot explain is the fact that the syllabicity constraint is stronger in Mandarin but weaker in Wenzhounese (Section 2), so I propose to combine SOT with LFG to capture the gradient effect of the syllabicity constraint (Section 3.2).

Following the double-tree model for the syntax-phonology interface (e.g., Dalrymple et al. 2019), my proposal for the syllabicity constraint does not assume any direct correspondence between syntax and phonology. This view deviates from LFG's projection architecture, under which we can easily posit a c-to-p-structure correspondence function (cf. Bögel 2015; Butt & King 1998), but I think this strictly modular view is worth pursuing for at least two reasons. On the one hand, it acknowledges the fact that syntax and phonology are fundamentally different. As such, it invites us to disentangle the information coming from these modules (as in my purely phonological analysis of phrasal stress) before proposing a less restrictive analysis where phonology could refer to syntactic information or *vice versa* (as in the rule of non-head stress). On the other hand, its adherence to domain specificity is supported in the wider context of cognitive science (Coltheart 1999; Reiss 2007; Scheer 2020).

However, there has been a concern that OT's global computational system might violate the purported strict modularity through the back door (Bögel 2015; Scheer 2011). In Section 3.3, I argue that this concern is rooted in Minimalist syntax and does not apply to constraint-based frameworks like LFG. In particular, faithfulness constraints (e.g., Align and Match) are essentially optimality-theorised correspondence functions rooted in standard LFG (e.g., the ϕ function from c- to f-structure), and they do not violate modularity as Scheer (2008, 2011, 2012) has claimed. This not withstanding, markedness constraints that simultaneously refer to phonological and syntactic information do violate domain specificity, and their legitimacy depends on whether the related phenomena (notably category-specific effects) can be reanalysed in a purely syntactic or phonological fashion.

Overall, the strictly modular analysis of the syllabicity constraint opens discussion of LFG's projection architecture when it comes to the incorporation of the phonological component. Furthermore, the stronger/weaker effect of the syllabicity constraint in Mandarin and Wenzhounese contributes to the SOT-LFG framework by showing that gradience is required not only in syntax (Asudeh 2001; Bresnan et al. 2001, 2007; *inter alia*) but also at the syntax-phonology interface.

A SOT computation simulation

A.1 Mandarin

```
#Load the pracma package
    install.packages('pracma')
    library(pracma)

#Generate two random values (z1, z2) that are normally distributed
    set.seed(1)
    z1 <- rnorm(100, mean=0, sd=1)
    z2 <- rnorm(100, mean=0, sd=1)


#FtBin = 55, *Struc = 50
    dis1 <- 55 + 2*z1
    dis2 <- 50 + 2*z2


#Put z1, z2, dis1, and dis2 to a dataframe named 'Mandarin'
    Mandarin <- data.frame(z1,z2,dis1,dis2)


#Create a new column named 'outrank'
    Mandarin$outrank <- c(dis1 > dis2)


#Count the numbers of TRUE and FALSE
#If dis1 > dis2 = FALSE, C2 (*Struc) outranks C1 (FtBin)
    count(Mandarin, outrank)
```

A.2 Wenzhounese

```
#Generate two random values (z1, z2) that are normally
    set.seed(1)
    z1 <- rnorm(100, mean=0, sd=1)
    z2 <- rnorm(100, mean=0, sd=1)

#FtBin = 50.8, *Struc = 50
    dis1 <- 50.8 + 2*z1
    dis2 <- 50 + 2*z2

#Put z1, z2, dis1, and dis2 to a dataframe named 'Wenzhou'
    Wenzhou <- data.frame(z1,z2,dis1,dis2)
```

```
#Create a new column named 'outrank'
    Wenzhou$outrank <- c(dis1 > dis2)

#Count the numbers of TRUE and FALSE
#If dis1 > dis2 = FALSE, C2 (*Struc) outranks C1 (FtBin)
    count(Wenzhou, outrank)
```

References

Almeida, Diogo. 2014. Subliminal wh-islands in Brazilian Portuguese and the consequences for syntactic theory. *Revista da ABRALIN* 13(2). 55–93. https://doi.org/10.5380/rabl.v13i2.39611.

Anderson, Stephen R. 2005. *Aspects of the theory of clitics*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199279906.001.0001.

Asudeh, Ash. 2001. Linking, optionality, and ambiguity in Marathi. In Peter Sells (ed.), *Formal and empirical issues in optimality-theoretic syntax*, 257–312. CSLI Publications.

Asudeh, Ash & Daniel Siddiqi. 2024. Morphology in LFG. In Mary Dalrymple (ed.), *The handbook of Lexical Functional Grammar*, Language Science Press. https://langsci-press.org/catalog/book/312.

Bellik, Jennifer, Junko Ito, Nick Kalivoda & Armin Mester. 2022. Matching and alignment. In Haruo Kubozono, Junko Ito & Armin Mester (eds.), *Prosody and prosodic interfaces*, 457–480. Oxford University Press. https://doi.org/10.1093/oso/9780198869740.003.0015.

Belyaev, Oleg. 2013. Optimal agreement at m-structure: Person in Dargwa. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG13 conference*, 90–110. CSLI Publications.

Bennett, Ryan & Emily Elfner. 2019. The syntax-prosody interface. *Annual Review of Linguistics* 5. 151–171. https://doi.org/10.1146/annurev-linguistics-011718-012503.

Bennett, Ryan, Emily Elfner & James McCloskey. 2016. Lightest to thre right: An apparently anomalous displacement in Irish. *Linguistic Inquiry* 47(2). 169–234. https://doi.org/10.1162/ling_a_00209.

Boersma, Paul. 1997. How we learn variation, optionality, and probability. In *IFA proceedings 21*, 43–58. Institute of Phonetic Sciences, University of Amsterdam.

Boersma, Paul & Bruce Hayes. 2001. Empirical tests of the Gradual Learning Algorithm. *Linguistic inquiry* 32(1). 45–86. https://doi.org/10.1162/002438901554586.

Bögel, Tina. 2015. *The syntax-prosody interface in Lexical Functional Grammar*. PhD thesis, Universität Konstanz.

Bögel, Tina. 2024. Prosody and its interfaces. In Mary Dalrymple (ed.),

The handbook of Lexical Functional Grammar, Language Science Press. https://langsci-press.org/catalog/book/312.
Bögel, Tina, Miriam Butt, Ronald M Kaplan, Tracy Holloway King & John T Maxwell III. 2009. Prosodic phonology in LFG: A new proposal. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG09 conference*, 146–166. CSLI Publications.
Borchers, Hans W. 2022. *Pracma: Practical numerical math functions*. https://CRAN.R-project.org/package=pracma.
Börjars, Kersti, Christopher Hicks & John Payne. 2018. Interdependencies in Chinese noun phrases. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG18 conference*, 109—128. CSLI Publications.
Börjars, Kersti & John Payne. 2021. Decategorialization and Chinese nouns. In I Wayan Arka, Ash Asudeh & Tracy Holloway King (eds.), *Modular design of grammar*, 221–237. Oxford University Press. https://doi.org/10.1093/oso/9780192844842.003.0014.
Bresnan, Joan. 2000. Optimal Syntax. In Joost Dekkers, Frank van der Leeuw & Jeroen van de Weijer (eds.), *Optimality Theory: Phonology, syntax and acquisition*, 334–385. Oxford University Press.
Bresnan, Joan. 2002. The lexicon in Optimality Theory. In Paola Merlo & Suzanne Stevenson (eds.), *The lexical basis of sentence processing: Formal, computational and experimental issues*, 39–58. John Benjamins. https://doi.org/10.1075/nlp.4.03bre.
Bresnan, Joan. 2007. Is syntactic knowledge probabilistic? Experiments with the English dative alternation. In Sam Featherston & Wolfgang Sternefeld (eds.), *Roots: Linguistics in search of its evidential base*, 77–96. Mouton de Gruyter.
Bresnan, Joan. 2016. Linguistics: The garden and the bush. *Computational Linguistics* 42(4). 599–617. https://doi.org/10.1162/COLI_a_00260.
Bresnan, Joan, Ashwini Deo & Devyani Sharma. 2007. Typology in variation: a probabilistic approach to *be* and *n't* in the *Survey of English Dialects*. *English Language and Linguistics* 11(2). 301–346. https://doi.org/10.1017/S1360674307002274.
Bresnan, Joan, Shipra Dingare & Christopher D. Manning. 2001. Soft constraints mirror hard constraints: Voice and person in English and Lummi. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG01 conference*, CSLI Publications.
Bresnan, Joan & Tatiana Nikitina. 2009. The gradience of the dative alternation. In Linda Uyechi & Lian-Hee Wee (eds.), *Reality exploration and discovery: Pattern interaction in language and life*, 161–184. CSLI Publications.
Bu, Hangbin. 2016. 吴语特殊语序初探 [A study of the special word order of Wu dialect]. *Journal of Jiangsu University of Science and Technology (Social Science Edition)* 16(3). 68–74.

Butt, Miriam & Tracy Holloway King. 1998. Interfacing phonology with LFG. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG98 conference*, CSLI Publications.

Chen, Matthew Y. 1987. The syntax of Xiamen tone sandhi. *Phonology* 4. 109–149.

Clark, Brady Z. 2004. *A Stochastic Optimality Theory approach to syntactic change*. PhD thesis, Stanford University.

Coltheart, Max. 1999. Modularity and cognition. *Trends in cognitive sciences* 3(3). 115–120.

Dalrymple, Mary, Ronald M Kaplan & Tracy Holloway King. 2004. Linguistic generalizations over descriptions. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG04 conference*, 199–208. CSLI Publications.

Dalrymple, Mary, Ronald M Kaplan & Tracy Holloway King. 2016. Economy of Expression as a principle of syntax. *Journal of Language Modelling* 3(2). 377–412. https://doi.org/10.15398/jlm.v3i2.82.

Dalrymple, Mary, John J Lowe & Louise Mycock. 2019. *The Oxford reference guide to Lexical Functional Grammar*. Oxford: Oxford University Press. https://doi.org/10.1093/oso/9780198733300.001.0001.

Dalrymple, Mary & Louise Mycock. 2011. The prosody-semantics interface. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG11 conference*, 173–193. CSLI Publications.

Duanmu, San. 2007. *The phonology of Standard Chinese*. Oxford University Press.

Duanmu, San. 2012. Word-length preferences in Chinese: A corpus study. *Journal of East Asian Linguistics* 21(1). 89–114. https://doi.org/10.1007/s10831-011-9087-y.

Duanmu, San, Shengli Feng, Yan Dong & Yingyue Zhang. 2018. A judgment study of length patterns in Chinese: Prosody, last resort, and other factors. *Journal of Chinese Linguistics* 46(1). 42–68. https://doi.org/10.1353/jcl.2017.0026.

Elias-Ulloa, Jose. 2021. Lexical category-governed neutralization to coronal and non-coronal place of articulation in latent consonants: The case of Shipibo-Konibo and Capanahua (Pano). *Languages* 6. 158. https://doi.org/10.3390/languages6040158.

Elordieta, Gorka. 2008. An overview of theories of the syntax-phonology interface. *Anuario del Seminario de Filología Vasca "Julio de Urquijo"* 42(1). 209–286.

Ernestus, Mirjam. 2011. Gradience and categoricality in phonological theory. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), *The Blackwell companion to phonology*, vol. 4, 1–22. Blackwell. https://doi.org/10.1002/9781444335262.wbctp0089.

Faust, Noam & Tobias Scheer. 2023. Ghost /ə/ and its manifestations in

the French Croissant. http://www.lel.ed.ac.uk/mfm/30mfm.html.
Featherston, Sam. 2005. Magnitude estimation and what it can do for your syntax: Some wh-constraints in German. *Lingua* 115(11). 1525–1550. https://doi.org/10.1016/j.lingua.2004.07.003.
Feng, Shengli. 1997. Prosodically determined word-formation in Mandarin Chinese. *Social Sciences in China* 4. 120–137.
Feng, Shengli. 2003. Prosodically constrained postverbal PPs in Mandarin Chinese. *Linguistics* 41(6). 1085–1122. https://doi.org/10.1515/ling.2003.035.
Feng, Shengli. 2011. 韵律句法学研究的历程与进展 [The past and present researches on Prosody Syntax in Chinese]. *Chinese Teaching in the World* 25(1). 13–31.
Feng, Shengli. 2019. *Prosodic syntax in Chinese: Theory and facts*. Routledge. https://doi.org/10.4324/9781351263283.
Féry, Caroline & Ruben Stoel. 2006. Gradient perception of intonation. In Gisbert Fanselow, Caroline Féry, Ralf Vogel & Matthias Schlesewsky (eds.), *Gradience in grammar: Generative perspectives*, 145–166. Oxford University Press.
Fodor, Jerry A. 1983. *The modularity of mind*. MIT press.
Gouskova, Maria. 2003. *Deriving enonomy: Syncope in optimality theory*. PhD thesis, University of Massachusetts Amherst.
Grimm, Nadine. 2023. Exponence and the functional load of grammatical tone in Gyeli. *Phonology* 1–29. https://doi.org/10.1017/S0952675723000131.
Guo, Shaoyu. 1938. 中国语词之弹性作用 [The function of elastic word length in Chinese]. *Yen Ching Hsueh Pao* 24. 1–34.
Her, One-Soon. 2012. Structure of classifiers and measure words: A Lexical Functional account. *Language and Linguistics* 13(6). 1211–1251.
Huang, Lijun & San Duanmu. 2013. 现代汉语词长弹性的量化研究 [Quantitative study of elastic word length in Modern Chinese]. *Linguistic Sciences* 12(1). 8–16.
Ito, Junko & Armin Mester. 1999. Realignment. In René Kager, Harry van der Hulst & Wim Zonneveld (eds.), *The prosody-morphology interface*, 188–217. Cambridge University Press.
Jackendoff, Ray. 2000. Fodorian modularity and representational modularity. In Yosef Grodzinsky, Lewis P Shapiro & David Swinney (eds.), *Language and the brain: Representation and processing*, 3–30. Academic Press. https://doi.org/10.1016/B978-012304260-6/50003-7.
Jiang, Li Julie, Peter Jenks & Jing Jin. 2022. The syntax of classifiers in Mandarin Chinese. In Chu-Ren Huang, Yen-Hwei Lin, I-Hsuan Chen & Yu-Yin Hsu (eds.), *The Cambridge handbook of Chinese linguistics*, 515–549. Cambridge University Press. https://doi.org/10.1017/9781108329019.028.

Kaplan, Ronald M. 1995. The formal architecture of Lexical-Functional Grammar. In Mary Dalrymple, Ronald M. Kaplan, John T. Maxwell III & Annie E Zaenen (eds.), *Formal issues in Lexical-Functional Grammar*, 7–27. CSLI Publications.

Kuhn, Jonas. 2007. Interfaces in constraint-based theories of grammar. In Gillian Ramchand & Charles Reiss (eds.), *The Oxford handbook of linguistic interfaces*, 613–650. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199247455.013.0020.

Kuhn, Jonas. 2024. LFG, Optimality Theory and learnability of languages. In Mary Dalrymple (ed.), *The handbook of Lexical Functional Grammar*, Language Science Press. https://langsci-press.org/catalog/book/312.

Lahiri, Aditi & Frans Plank. 2022. Phonological phrasing: Approaches to grouping at lower levels of the prosodic hierarchy. In B. Elan Dresher & Harry van der Hulst (eds.), *The Oxford history of phonology*, 134–162. Oxford University Press. https://doi.org/10.1093/oso/9780198796800.003.0007.

Lee, Hanjung. 2004. Minimality in a lexicalist Optimality Theory. In Arthur Stepanov, Gisbert Fanselow & Ralf Vogel (eds.), *Minimality effects in syntax*, 241–288. Mouton de Gruyter.

Liao, Wei-wen Roger. 2014. Morphology. In C.-T. James Huang, Y.-H Audrey Li & Andrew Simpson (eds.), *The handbook of Chinese linguistics*, 3–25. Blackwell. https://doi.org/10.1002/9781118584552.ch1.

Lowe, John J. 2016. Clitics: Separating syntax and prosody. *Journal of Linguistics* 52(2). 375–419. https://doi.org/10.1017/S002222671500002X.

Lowe, John J & Oleg Belyaev. 2015. Clitic positioning in Ossetic. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG15 conference*, 229–249. CSLI Publications.

Lü, Shuxiang. 1963. 现代汉语单双音节问题初探 [A preliminary research on monosyllable-disyllable combinations in modern Chinese]. *Studies of the Chinese Language* 1. 10–22.

McCarthy, John J. & Alan Prince. 1993. Generalized alignment. In Geert Booij & Jaap van Marle (eds.), *The yearbook of morphology 1993*, 79–153. Springer.

McEnery, Tony & Richard Xiao. 2004. The Lancaster corpus of Mandarin Chinese. https://www.lancaster.ac.uk/fass/projects/corpus/LCMC/.

Mohanan, Tara & Karuvannur Puthanveettil Mohanan. 2003. Input, output candidates, markedness constraints, and ineffability in OT-LFG. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG03 conference*, 307–327. CSLI Publications.

Mycock, Louise. 2006. *The typology of constituent questions: a Lexical-Functional Grammar analysis of 'wh'-questions*. PhD thesis, University of Manchester.

Mycock, Louise. 2015. Syntax and its interfaces: An overview. In Tibor Kiss

& Artemis Alexiadou (eds.), *Syntax – theory and analysis*, 24–69. Mouton de Gruyter. https://doi.org/10.1515/9783110377408.24.

Mycock, Louise. 2023. The typology of "wh"-questions in a theory without movement: A Lexical-Functional Grammar analysis of constituent questions. Ms. University of Oxford.

Mycock, Louise & John J Lowe. 2013. The prosodic marking of discourse functions. In Miriam Butt & Tracy Holloway King (eds.), *Proceedings of the LFG13 conference*, 440–460. CSLI Publications.

Nespor, Marina & Irene Vogel. 1986. *Prosodic phonology*. Foris.

Newell, Heather. 2021. Deriving Level 1/Level 2 affix classes in English: Floating vowels, cyclic syntax. *Acta Linguistica Academica* 68(1-2). 31–76.

Partee, Barbara H., Alice ter Meulen & Robert E. Wall. 1990. *Mathematical methods in linguistics*. Kluwer Academic Publishers.

Prince, Alan & Paul Smolensky. 2004. *Optimality Theory: Constraint interaction in generative grammar*. Blackwell. https://doi.org/10.1002/9780470759400.

Qin, Zuxuan & San Duanmu. 2017. A judgment study of word-length preferences in Chinese NN compounds. *Lingua* 198. 1–21. http://dx.doi.org/10.1016/j.lingua.2017.06.012.

R Core Team. 2022. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/.

Reiss, Charles. 2007. Modularity in the "sound" domain: Implicationsfor the purview of Universal Grammar. In Gillian Ramchand & Charles Reiss (eds.), *The Oxford handbook of linguistic interfaces*, 53–79. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199247455.013.0003.

Sande, Hannah. 2023. Is grammatical tone item-based or process-based? *Phonology* 1–44. https://doi.org/10.1017/S0952675723000106.

Scheer, Tobias. 2008. Why the prosodic hierarchy is a diacritic and why the interface must be direct. In Jutta Hartmann, Veronika Hegedüs & Henk van Riemsdijk (eds.), *Sounds of silence: Empty elements in syntax and phonology*, 145–192. Elsevier.

Scheer, Tobias. 2011. *A guide to morphosyntax-phonology interface theories: How extra-phonological information is treated in phonology since Trubetzkoy's Grenzsignale*. Mouton de Gruyter.

Scheer, Tobias. 2012. *Direct interface and one-channel translation: A non-diacritic theory of the morphosyntax-phonology interface*. Mouton de Gruyter.

Scheer, Tobias. 2020. On the lexical character of intermodular communication. *Radical: A Journal of Phonology* 1. 183–239.

Scheer, Tobias. 2023. Recursion in phonology: Anatomy of a misunderstanding. In Jeroen van de Weijer (ed.), *Representing phonological detail:*

Segmental structure and representations, 265–287. Monton de Gruyter. https://doi.org/10.1515/9783110730098.
Scheer, Tobias & Péter Szigetvári. 2005. Unified representations for stress and the syllable. *Phonology* 22(1). 37–75.
Selkirk, Elisabeth. 1986. On derived domains in sentence phonology. *Phonology* 3. 371–405.
Selkirk, Elisabeth. 2009. On clause and intonational phrase in Japanese: The syntactic grounding of prosodic constituent structure. *Gengo Kenkyu* 136. 35–73.
Selkirk, Elisabeth. 2011. The syntax-phonology interface. In John Goldsmith, Jason Riggle & Alan C. L. Yu (eds.), *The handbook of phonological theory*, 435–484. Blackwell 2nd edn.
Shannon, Claude Elwood. 1948. A mathematical theory of communication. *The Bell system technical journal* 27(3). 379–423. https://doi.org/10.1002/j.1538-7305.1948.tb01338.x.
Smith, Jennifer L. 2001. Lexical category and phonological contrast. In R Kirchner, J Pater & W Wikely (eds.), *Proceedings of the workshop on the lexicon in phonetics and phonology*, 61–72.
Smith, Jennifer L. 2011. Category-specific effects. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), *The Blackwell companion to phonology*, 1–25. Blackwell. https://doi.org/10.1002/9781444335262.wbctp0102.
Spencer, Andrew & Ana R. Luis. 2012. *Clitics: An introduction*. Cambridge University Press. https://doi.org/10.1017/CBO9781139033763.
Tamelan, Thersia & I Wayan Arka. 2021. Adjuncts at the syntax-prosody interface in nominal structures in Dela. In Miriam Butt, Jamie Y. Findlay & Ida Toivonen (eds.), *Proceedings of the LFG21 conference*, 264–284. CSLI Publications.
Wheeldon, Linda R & Aditi Lahiri. 2002. The minimal unit of phonological encoding: prosodic or lexical word. *Cognition* 85. B31–B41. https://doi.org/10.1016/S0010-0277(02)00103-8.
Wynne, Hilary, Linda Wheeldon & Aditi Lahiri. 2018. Compounds, phrases and clitics in connected speech. *Journal of Memory and Language* 98. 45–58. https://doi.org/10.1016/j.jml.2017.08.001.
Xie, Chen. to appear. Gradience at the syntax-phonology interface: Prosodically constrained VPs in Mandarin and Wenzhounese. Ms. University of Oxford.
Zhan, Weidong, Rui Guo, Baobao Chang, Yirong Chen & Long Chen. 2019. The building of the CCL corpus: Its design and implementation. *Corpus Linguistics* 6(1). 71–86. http://ccl.pku.edu.cn:8080/ccl_corpus.
Zhengzhang, Shangfang. 2008. 温州方言志 *[A survey of Wenzhounese]*. Zhonghua Book Company.