Constituency in sentence phonology: an introduction*

Elisabeth Selkirk
University of Massachusetts Amherst

Seunghun J. Lee
Central Connecticut State University and University of Johannesburg

Some general questions about the role of constituency in sentence phonology and phonetics have informed research since Chomsky & Halle (1968) first put forward the hypothesis that the phonological representation of a sentence is in part a function of its syntactic representation.

(i) What aspects of syntactic structure are relevant (directly or indirectly) to the rules or constraints of phonology and phonetics?

(ii) What role is there for the syntactic derivation in determining surface phonological or phonetic patterning?

(iii) Is the interaction of syntax and phonology a one-way street, with syntactic structure affecting phonology, but phonology not affecting syntactic representation?

(iv) Is the effect of syntactic structure on phonology and phonetics direct, or is it mediated by a properly phonological (prosodic) structure that reflects, but is not identical to, syntactic representation?

(v) What sorts of non-syntactic influences may contribute to determining the constituent structure to which sentence phonology and phonetics are sensitive?

(vi) Assuming that the grammar defines a prosodic constituent structure that is distinct from syntactic structure, just what is the nature of its representation and its relation to syntax?

(vii) What other properties of phonological representation (features, featural linking, segments, quantity, syllabification, footing, stress/prominence) or of phonetic interpretation depend on the higher-order prosodic constituent structure of the sentence?

(viii) What is the nature of the grammatical constraints that express this sensitivity to prosodic structure?

(ix) What are the elements and modules of a theory of grammar that succeeds in providing an insightful cross-linguistic, typological, approach to constituent structure-sensitivity in phonology and phonetics?[1]

§1 of this introduction takes up questions (i), (iv), (v) and (vi). §2 examines (vii) and (viii), and §3 looks very briefly at (ii) and (iii); it is there as a reminder of the broader theoretical context in which the issues raised in this introduction and in the papers in this issue should be placed. The very general question in (ix) is of course touched on in all of these sections.

The six papers in this thematic issue of *Phonology* report on sentence-level constituent structure-sensitive phenomena from a wide variety of languages: German, Lekeitio Basque, Hungarian, Bàsàá, Shingazidja, Copperbelt Bemba and Akan. All the papers assume that the hierarchical constituent structure directly impinging on sentence phonology or phonetics is composed of phonological – i.e. prosodic – constituents; they assume that the effect of syntactic constituency on constituency-sensitive phenomena examined is indirect, and confined to the submodule of grammar which defines the relation between syntactic and prosodic constituency (as in Nespor & Vogel 1986, Selkirk 1986, 1996, 2011, Truckenbrodt 1999, Elfner 2012 and others).[2] Another shared aspect of these papers is that the phonological and phonetic phenomena investigated are quite general in character, and depend in no way on the particularities of the morphosyntactic feature composition of the formatives, words or phrases that make up the sentence; they are apparently phenomena that are defined by principles of the properly phonological and phonetic modules of the grammar, restricted only by the

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[1] Valuable contributions to our understanding of these issues have appeared in this journal since its earliest days, for example in Ladd (1986b) and Zwicky & Kaisse (1987). In that same decade, various books, including Selkirk (1984), Kaisse (1985) and Nespor & Vogel (1986), presented differing perspectives on the syntax–phonology interface and the organisation of the grammar. That decade ended with the publication of Inkelas & Zec (1990).

[2] An important line of research has assumed that there is no role at all role for prosodic structure (PrStruc) in sentence phonology, rather only a direct effect of syntax on phonology. See the work on Kimatuumbi of Odden (1987), for example, and in more recent years Wagner (2005), Pak (2008) and Tokizaki (2008), *inter alia*. Direct comparisons of these constituency-as-only-syntax theories with PrStruc-based theories with regard to the empirical phenomena and generalisations in those works are not undertaken in the papers in this issue, but alternative prosodic constituency-based approaches to at least some of the data in these works is implicit here, and explicit in some prior work, such as Truckenbrodt (1999) on Kimatuumbi.

prosodic constituent structure of the surface phonological representation and its tonal and segmental feature composition. This shared theoretical background and commonality in the nature of the structure-sensitivity exhibited in the data alongside the broad range of both theoretical and empirical topics that are taken up in this issue allow for advances in our understanding of some of the questions outlined above.

1 Defining prosodic structure representations

The nature of the relation between syntactic constituency (SStruc) and prosodic constituency (PrStruc) and the evaluation of competing theories of the constraints that define this SStruc–PrStruc relation are topics in virtually all the contributions. Specifically, Selkirk's (2009, 2011) 'Match theory', which holds that the distinct syntactic constituent types word, phrase and clause are matched with correspondingly distinct prosodic constituent types, is compared with variants of the theory that it is just the edges of syntactic constituents that line up with prosodic constituents (Selkirk 1986, 1996, Truckenbrodt 1995, 1999). As for the nature of prosodic constituent structure itself, PrStruc-sensitive phonological and phonetic phenomena treated in five of the six papers here provide evidence for the recursive nature of intonational phrasing and/or phonological phrasing, supporting the contention first put on the table by Ladd (1986a) that PrStruc-organisation is not necessarily strictly layered (*contra* Selkirk 1984, 1986, Beckman & Pierrehumbert 1986 and Nespor & Vogel 1986, and much subsequent work in prosodic phonology). Moreover, in their sustained examination of the syntactic constituent correlates of the intonational and/or phonological phrasing that play a role in sentence phonology and phonetics, these papers provide evidence for a systematic correspondence between the PrStruc-category types phonological phrase (φ) and intonational phrase (ι) on the one hand and the syntactic category types phrase and clause on the other, consistent with Selkirk's (2006, 2011) proposal that the very types of prosodic category above the foot and syllable are syntactically grounded and universal. What identifies φ and ι cross-linguistically, on this view, is their correspondence relation to syntactic constituents of the same sentence (phrases and clauses respectively), not any particular phonological or phonetic properties (*contra* Beckman & Pierrehumbert 1986, Jun 2005 and others).

The overarching idea of Match theory (Selkirk 2009, 2011) is that the distribution of prosodic constituency in a sentence in the default baseline case reflects a grammatically imposed correspondence relation between SStruc-constituency and PrStruc-constituency. This correspondence relation identifies the basic constituent types of sentence-level prosodic structure – ι, φ and ω (prosodic word)[3] – and is a source of their recursive organisation.

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[3] There is no need to assume a prosodic category utterance alongside ι, φ and ω, *contra* Selkirk (1981), for example. 'Utterance' is merely the name of the highest ι in the potentially recursive ι structure of a sentence (see Selkirk 2009), which would be characterised as a 'maximal ι' in terms of Ito & Mester's theory of recursion-

The SStruc–PrStruc correspondence constraints of Match theory call for the clauses, phrases and words of a syntactic structure to match up with corresponding constituents in phonological representation; the terms 'intonational phrase', 'phonological phrase' and 'prosodic word' can be thought of as nicknames for the distinct prosodic constituent types that correspond to these distinct types of syntactic constituent. A central issue that remains to be resolved is the precise identity of the syntactic types 'clause', 'phrase' and 'word' to which the prosodic constituent types ι, φ and ω correspond. The papers in this issue that examine the syntax of intonational phrasing (Truckenbrodt & Féry, Hamlaoui & Szendrői, O'Connor & Patin) make a valuable contribution in this area.[4] They collectively support the view that ι has two distinct but plausibly related correlates in syntax, one of them the not necessarily clause-like unit defining a distinct 'speech act' and the other a properly syntactic clause-like constituent. The term 'clause' in the SStruc–PrStruc correspondence constraint MATCHCLAUSE must thus be understood to have these two facets. And, opening up new territory for further investigation, Hamlaoui & Szendrői make a strong case for the proposal that the syntactic constituent that counts as a 'clause' for intonational phrasing is the phrase that is immediately headed by the overt inflected main verb of the sentence (along with its specifier), in whatever surface position it may appear, resulting in the possibility of restricted variation both language-internally and crosslinguistically in the syntax of intonational phrasing. As for the syntactic correlate(s) of φ, it is generally assumed in phonological work addressing the syntax–phonology interface that syntactic phrases headed by a lexical item – N, V, A – will, cross-categorially, all correlate with phonological phrasing. It is also assumed that in principle they have this capacity regardless of whether these syntactic phrases consist of one lexical word (a non-branching phrase) or more than one lexical word (a branching phrase).[5] The data presented in the papers in this issue is consistent with these general assumptions. But the question whether, or how, the lexical/functional category distinction may affect φ organisation is perhaps not yet settled, as seen in the admittedly brief discussions in this issue.[6] Furthermore, the question of the syntactic

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   based prosodic subcategories (Ito & Mester 2009a, b, 2012, 2013), discussed below in §2.

[4] For further background the reader is referred to the review of prior proposals regarding the syntax of intonational phrasing in the Hamlaoui & Szendrői paper in this issue.

[5] In languages where a single-word syntactic phrase does not correspond to a φ, a PrStruc-markedness constraint calling for a φ to be minimally binary, or branching, will outrank MATCHPHRASE, as in the Selkirk (2011) account of single-word *vs.* multiword φ organisation in Xitsonga. For earlier proposals regarding the role for binarity or branching in ω, φ or ι, see, among others, Nespor & Vogel (1986) on branching-driven 'restructuring', and Inkelas & Zec (1995) and Ito & Mester (2003) on prosodic binarity restrictions.

[6] A distinction between the phonological properties of functional and lexical category words was recognised in early generative accounts of word-boundary placement (Chomsky & Halle 1968, Selkirk 1972). In the context of PrStruc-theory, the distinction emerges in the requirement that only lexical words systematically correspond to prosodic words (see e.g. Selkirk 1996, Werle 2009). The suggestion that

correlates of prosodic wordhood is not addressed in any of the papers in this issue. Continued research on these and other issues relating to the correspondence between syntactic and prosodic constituency is needed in order to deepen our understanding of the syntactic basis of prosodic structure.[7]

Of course, the reason for assuming the existence of an independent prosodic structure in the first place is that the constituent structure with respect to which structure-sensitive phenomena of phonology and phonetics are defined may diverge in significant respects from the syntactic structure of the sentence. The hypothesis of Match theory is that some such divergences, or non-isomorphisms, are the consequence of properly phonological pressures on the hierarchical structure of phonological representation. Expressed in terms of universal phonological markedness constraints, these pressures may result in a PrStruc-representation which diverges from the prosodic structure that is called for by the universal SStruc–PrStruc MATCH constraints of the grammar. In an optimality-theoretic approach, such divergences can be understood as the consequence of a subordination of some MATCH constraint(s) to some conflicting PrStruc-markedness constraint(s) in the ranking specified for a language. We refer to such constraints and their language-particular ranking as the PrStruc-formation module of the grammar. It follows from this theory of PrStruc-formation that languages may differ in the prosodic structure that is formed for sentences of particular syntactic types precisely in ways that would be predicted by independently motivated phonological constraints on well-formed prosodic structure.

There may, in addition, be sources other than phonological markedness constraints for divergences from syntactic structure in the prosodic structure. For example, the status of a constituent as a contrastive Focus, represented as morphosyntactic F-marking, may, depending on the language, be phonologically spelled out as prosodic prominence and its concomitant phrasing (cf. e.g. Truckenbrodt 1995, Selkirk 2002, Katz & Selkirk 2011). This language-particular spell-out of F-marking as maximal prosodic prominence could be viewed as a kind of prosodic morphology.

It happens that none of the papers contained in this issue suggest the existence of constituents of prosodic structure that fail to correspond to appropriate constituents of syntactic structure. The underrepresentation here of evidence for this sort of non-isomorphism may simply reveal the truth of the assumption that, in the default case, prosodic structure does essentially match up with syntactic structure – in other words that MATCH constraints on SStruc–PrStruc constituency correspondence

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syntactic phrases not headed by lexical items fail to correspond to φ's was made in Selkirk & Shen (1990). For further discussion, see Truckenbrodt (1999, 2007).

[7] Another topic that is not addressed in the papers in this issue concerns the question whether prosodic structure is built up cyclically/phasally, as a part of a minimalist Spell-out of syntactic constituency (see §3). The papers can be taken to assume, implicitly, that the prosodic structure of phonological representation is defined in one fell swoop, with respect to a complete and fully available surface syntactic representation of the sentence.

outrank any PrStruc-markedness constraints that would be a source of mismatches. It's also possible, though, that further variation in the syntactic and phonological properties of the sentences investigated in these languages, or the conditions under which they are produced, would show the effects of prosodic markedness constraints or other factors which do lead to non-isomorphisms between the prosodic and syntactic structure of sentences. For example, it is known from previous work on Lekeitio Basque, one of the languages examined in this issue, that the lexical property of a word as pitch-accented or accentless has a significant impact on φ organisation;[8] this effect of accent status on φ structure has been seen as the consequence of phonological markedness constraints on the relation between tonal accent and prominence and between prominence and phrasing (see e.g. Elordieta 2007, Selkirk & Elordieta 2010, Selkirk 2011, Elordieta & Unamuno in preparation). Other not obviously grammatical factors like speech rate, paralinguistic emphasis and overall syllable count also appear to contribute to PrStruc-formation.[9]

The set of phonological markedness constraints that may have an impact on PrStruc-formation is still to be fully delineated. Are there phonological constraints that bear only on the properties of prosodic structure itself? To answer this question it must be determined whether anything is different about the general properties of prosodic structure as compared to syntactic constituent structure. For example, consider the Match-theory proposal that the very category types of higher-order prosodic structure – ι, φ and ω – are grounded in the syntactic category types clause, phrase and word. If this proposal is right, one might ask whether the theory of phonological representations would have anything to say about the presence of ι, φ and ω, or about the relations between them. Match theory already predicts that the phonological representation of any sentence in a language consists of at least one ι (corresponding to a syntactic clause or speech act), which consists of at least one φ (corresponding to a syntactic phrase), which in turn consists of at least one ω (corresponding to a morphosyntactic word). True manifestations of the status of ι, φ and ω as elements of the theory of phonological representation alongside Ft and σ would be the existence of prosodic markedness constraints familiar from accounts of the foot (e.g. Hayes 1995) that

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[8] In Lekeitio Basque, as in the case of Tokyo Japanese, at most one lexically pitch accented word may be contained in a single φ. In Lekeitio Basque, a syntactic phrase that consists only of lexically unaccented material will fail to correspond to any φ (Elordieta 1997, Elordieta & Unamuno in preparation). This is not the case in Tokyo Japanese (see e.g. Selkirk & Tateishi 1988, Kubozono 1993, Selkirk *et al*. 2003).

[9] As is known, words in isolation may have, in addition to the normal phonological or phonetic properties associated with ω, the properties of phrases, both φ and ι. Slow, deliberate, pronunciations or paralinguistically emphatic styles of speaking likely also involve possible promotion of ω to φ or of φ to ι (with accompanying intonational effects), while faster speech sometimes has the opposite effect. These 'stylistic' effects on PrStruc-organisation are probably to be distinguished from the role of syllable count in determining the likelihood that a subject or object is given the prosodic status of a ι in languages of the Iberian Peninsula (Elordieta *et al*. 2005, Prieto 2005).

require that a prosodic constituent of type ι, φ or ω be prosodically binary or prosodically headed (i.e. contain a most prominent daughter constituent), or that the prosodic head prominence of a constituent of that category be located at the right as opposed to the left. Cases illustrating the role of binarity, prosodic headedness and the edge-positioning of heads in prosodic structure are reviewed in Selkirk (2011: §3.1).

Other markedness constraints on prosodic structure that may affect constituents of types ι, φ and ω (as well as Ft and σ) involve domination and sisterhood relations between the constituents of prosodic structure. For example, Selkirk (1996) proposes four distinct phonological markedness constraints on domination relations between prosodic categories: HEADEDNESS, LAYEREDNESS, NON-RECURSIVITY and EXHAUSTIVITY. These constraints involve a variable C^i, standing for 'prosodic constituent of level i in the prosodic hierarchy $\iota/\varphi/\omega/\text{Ft}/\sigma$'. The notion of inherent 'level' distinctions in the set of prosodic constituent types in phonology is assumed to play a role in the characterisation of constraints on prosodic domination. For example, HEADEDNESS requires that 'any C^i must dominate a C^{i-1} (except if $C^i = \sigma$)'. Its function is to capture the generalisation that any ι must dominate a φ, any φ must dominate a ω and any ω must dominate a Ft. But, as discussed above, given the Match theory of the syntactic–prosodic constituency relation and the nature of syntactic structure, the domination by an ι of a φ or by a φ of a ω follows without any stipulation in the phonology itself. So HEADEDNESS, as a phonological constraint, may lack independent motivation. As for NON-RECURSIVITY, which specifies that 'no C^i dominates C^j, $j = i$', its existence is in doubt, given mounting evidence – testified to by papers in this issue and elsewhere – that recursion of ι and φ is systematically present in phonological representation, due to the relation of prosodic recursion to recursion in syntax. It remains to be seen whether the NON-RECURSIVITY constraint is indeed responsible for any empirically supported departures from the recursion in prosodic structure that would be expected in the case of recursion in the corresponding syntactic structure of a sentence.

Consider now the constraint LAYEREDNESS, which states that 'no C^i dominates a C^j, $j > i$'. Given the nature of syntactic structure, together with Match theory, PrStruc-configurations are predicted that violate LAYEREDNESS. Commonplace syntactic structures, like DPs which contain/dominate relative clauses – [N […]$_{CP}$]$_{DP}$ – or VPs which contain/dominate embedded clauses that are complements to verbs – [V […]$_{CP}$]$_{VP}$ – would be predicted to correspond to prosodic structures in which an ι, corresponding to a clause, is dominated by and contained within a φ, which corresponds to a syntactic phrase, e.g. $((...)_\iota)_\varphi$. Are such LAYEREDNESS violations ever actually attested in surface phonology? If so, does this mean that LAYEREDNESS is not a constraint of natural language, or only that it is a violable constraint? Is there any evidence that such prosodic configurations are avoided or categorically absent in surface phonological representations in some language(s)? If the answer to the latter were yes, the notion that a LAYEREDNESS constraint excludes the offending configuration in prosodic

structure would be supported. And it would demonstrate that PrStruc-representations are subject to restrictions without analogues in the syntax. It is perhaps too early to be even mildly confident of answers to these questions about LAYEREDNESS, given the paucity of work in sentence phonology on syntactic structures involving the embedding of clauses within nominal or verbal projections, or involving phrases within words.[10] The O'Connor & Patin paper on the syntax and prosodic structure of nominal apposition in Shingazidja in this issue does entertain the notion that LAYEREDNESS outranks MATCHPHRASE, and thereby drives an absence of φ structure that dominates ι structure within the DP. More work in this area is required.

EXHAUSTIVITY is the fourth of the proposed constraints on prosodic domination in Selkirk (1996): 'no C^i immediately dominates a constituent C^j, $j < i - 1$'. Expressed as a constraint on the domination relation, it encodes the idea that the daughter(s) of a constituent at level C^i of the prosodic hierarchy must be a sequence of constituents at the next level down in the prosodic hierarchy. Myrberg (2013) argues instead (*contra* Selkirk 1996) that the prosodic property that is relevant to capturing the spirit of EXHAUSTIVITY is that of prosodic sisterhood, as embodied in the prosodic markedness constraint EQUALSISTERS: sister nodes in prosodic structure are instantiations of the same prosodic category (Myrberg 2013: 75). Myrberg's case is based on the observation in Swedish that the prosodic structure $((...)_\iota (...)_\varphi)_\iota$ produced by Match in relation to the syntactic structure $[[...]_{\text{clause}} [...]_{\text{phrase}}]_{\text{clause}}$ is unstable, found in variation with structures that either promote the φ to ι, producing a sequence $((...)_\iota (...)_\iota)_\iota$, or incorporate the material of the clause on the left into the same φ as the VP material, producing $((... ...)_\varphi)_\iota$. In a similar vein, the constraint STRONGSTART (Selkirk 2011), which requires that the initial daughter of a prosodic constituent not be lower in the prosodic hierarchy than the sister constituent it precedes, has been offered as an explanation for language-particular differences in the prosodic phrasing of 'topic' phrases lying at the left syntactic periphery outside clausal constituents, for example.[11] In Xitsonga (Kisseberth 1994) topics are ι, as in the first ι of $((...)_\iota (...)_\iota)_\iota$, while in Northern Sotho (Zerbian 2006, 2007) they remain as phonological phrases: $((...)_\varphi (...)_\iota)_\iota$.[12] Constraints like these on the sequencing of sister constituent types in prosodic structure have no analogue in properties of syntactic structure, and so appear to support the claim that 'ideal'

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[10] But see the Downing *et al.* (2010) collection on Bantu relative clauses, and Pak (2008) on Luganda embedded clauses, both relative clauses and verbal complements.

[11] Selkirk (2011) reviews independent evidence for the asymmetric, sisterhood-based STRONGSTART constraint from phenomena at lower levels of prosodic structure. See also Elfner (2012, 2015) on the role of STRONGSTART at the level of φ in Connemara Irish

[12] The role of STRONGSTART in the prosodic structure of sentence-initial topics is taken up in Hamlaoui & Szendrői in this issue.

phonological representations have properties that are formally distinct from syntactic representation, even while sharing properties with it.

There is an additional principle governing PrStruc-organisation which also crucially distinguishes prosodic structure from syntactic structure, and which has far-reaching implications for the relation between syntactic and prosodic constituency representations. This is the requirement that any constituent of prosodic structure consist of overt phonological material: there are no 'empty' constituents in phonological representation, e.g. $*(\emptyset)_{\varphi}$, $*(\emptyset)_{\omega}$. Call this the NoEmptyConstituent constraint on the nature of PrStruc-representations. It captures the long-recognised generalisation that entities like the traces of syntactic movement or abstract PRO subjects or objects, as well as lacking phonological segments and features, make no contribution to the prosodic structure of the sentence, and hence have no relevance for phonology and phonetics. This constraint requires in effect that any sort of abstract, un-spelled-out, phonologically unrealised word or morpheme – whether an abstract light verb in a VP shell, an abstract Tns head of TP, or an abstract Top head of a TopicP – would itself have no PrStruc-realisation. In addition, Elfner (2012, 2015) hypothesises on the basis of recursion-sensitive phrasal tonology in Connemara Irish that there can be no constituent π_1 of prosodic structure whose terminal string is non-distinct from the terminal string of a constituent π_2 that is dominated by π_1. According to the constraint posited by Elfner, there will be no corresponding φ in PrStruc-representation for a syntactic phrase XP that contains, for example, an empty head and a phonologically overt phrase YP, e.g. [[abcde]$_{YP}$ [$\emptyset$]$_X$]$_{XP}$. Only the φ corresponding to YP is given a representation: (abcde)$_{\varphi}$. A representation that consists of a phonologically non-branching nesting of two φ's is impossible: $*((abcde)_{\varphi})_{\varphi}$. Call this the NoNon-distinctConstituent constraint. The joint consequences of the NoEmptyConstituent and the NoNon-distinctConstituent constraints are considerable. Together they imply far less embedding or recursion in the phonological representation of phrasal constituency than can be posited in the syntactic representation on morphosyntactic and/or semantic grounds.[13]

In sum, there does seem to be evidence for properly phonological constraints on prosodic constituent structure. These constraints are responsible for phonologically motivated non-isomorphism-creating 're-adjustments' in the prosodic constituent structure that would otherwise be inherited – through Match constraints – from the syntactic constituent structure of a sentence. Among the phonological markedness constraints on prosodic structure that have been discussed above, NoEmptyConstituent and NoNon-distinctConstituent, which anchor the presence of prosodic

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[13] Note moreover that the widely assumed irrelevance to the SStruc–PrStruc correspondence relation of syntactic phrases that are projected from overt functional heads, be they prepositions, determiners or verbal auxiliaries, predicts even more instances where PrStruc-representations show fewer φ's, in particular fewer instances of phrasal recursion or embedding, than are found in syntactic representation (cf. note 6).

constituency in the presence of a distinct phonologically overt terminal string, seem likely to be universally inviolable, and so to place universal limits on the capacity of MATCH constraints to force prosodic constituency to match up with syntactic constituency. Certain of the other markedness constraints discussed above govern relations between prosodic constituent types within prosodic structure, as with the penalising of differences in category type of successive prosodic constituents that is seen in the constraints EQUALSISTERS and STRONGSTART. Whether constraints that penalise certain domination relations are also required will depend on establishing empirical motivation for LAYEREDNESS or NON-RECURSIVITY. In addition, there are phonological markedness constraints governing the relation between prosodic head prominence (stress) and prosodic constituency, or between tone and prosodic constituency. All these also have the potential for establishing divergences between prosodic structure and the syntactic structure upon which prosodic structure is based, at word level and above. What we are calling the module of PrStruc-formation in grammar is the ranking – largely language-particular – of the MATCH constraints that define the correspondence between the constituents of syntactic and phonological representation and the properly phonological markedness constraints that contribute to defining prosodic structure.

From the perspective of prosodic structure, then, the theory of the distribution of PrStruc-sensitive phenomena in sentence phonology and phonetics, both within a language and cross-linguistically, contains three essential components: a theory of possible input syntactic structures from language to language, a theory of possible differences in PrStruc-formation (which depend on the language-particular interaction of phonological markedness constraints with constraints on SStruc–PrStruc correspondence, as discussed above) and a theory of PrStruc-sensitivity *per se*, i.e. a theory of just how prosodic structure restricts the distribution of other aspects of phonological representation or phonetic interpretation.

2 Prosodic structure-sensitivity in phonology and phonetics

PrStruc-sensitivity refers to the relation between prosodic constituency and phenomena involving other elements of phonological representation or aspects of phonetic interpretation. PrStruc-sensitivity is what is at issue when one speaks of the prosodic 'domain' of a particular phonological rule or constraint or of a phonetic process in a particular language. It is probably fair to say that currently there is no widely shared common understanding of the nature of PrStruc-sensitivity in phonology and phonetics.

Phonology and phonetics have the property that they deal crucially with a fully linearised phonological representation. Linear order and adjacency of the 'terminal' elements of the representation are factors that must be taken into account in the understanding of possible phonological and

phonetic phenomena in language. Discovering the relevant notions of adjacency is not a trivial matter, and depends on the theory of surface phonological representation itself, as research in phonology over the last decades has shown. For example, the (autosegmental) multiple linking of tone is assumed to require linear adjacency of tone-bearing units (TBUs), although not segmental adjacency. Moreover, TBU-based adjacency is a necessary, but not sufficient, condition on tonal multiple linking. A CRISPEDGE constraint (Itô & Mester 1999) may rule out multiple linking of tone in cases where adjacent TBUs are separated by the left edge of a φ, for example (see below). Speaking generally, the phonology of a language may impose requirements that particular properties of the output terminal string of the phonology be positioned with respect to particular properties of the hierarchical prosodic constituent organisation.

The papers in this issue all examine phonological or phonetic phenomena whose distribution within a sentence is characterised in terms of the prosodic constituent structure of the sentence. They provide evidence that will help us address a core question: what aspects of PrStruc-representation are appealed to in the constraints or principles of phonology and phonetics that are PrStruc-sensitive? The phenomena examined range from quantitative patterns of partial pitch reset that are found at the left edge of ι's in German (Truckenbrodt & Féry) and at the left edge of φ's in Lekeitio Basque (Elordieta) to phonological phenomena like tonal feature spreading in Copperbelt Bemba (Kula & Bickmore) and Shingazidja (O'Connor & Patin) or vocalic feature spreading (vowel harmony) in Akan (Kügler) that are blocked at the edges of certain prosodic constituents. Other cases involve constraints calling for the positioning of a tone at the left edge of ι in Hungarian (Hamlaoui & Szendrői), or at the right edge of ι in Shingazidja (O'Connor & Patin) or of φ in Copperbelt Bemba (Kula & Bickmore).

A key component of the theory of PrStruc-sensitivity in phonology and phonetics is the theory of prosodic category types. For example, Ito & Mester (2009a, b, 2012, 2013) argue that subtypes of the basic prosodic categories ι, φ and ω are defined in terms of their position within a recursive phonological ι, φ or ω structure: a maximal φ is a φ not dominated by any other φ, and a minimal φ is a φ dominating no other φ. Maximal and minimal ι and ω are defined similarly. As Ito & Mester demonstrate, postulating the general notion φ and the related prosodic recursion-based subcategories φ_{max} and φ_{min} allows for an insightful account of structure-sensitivity in the tonal phonology and phonetics of sentences in Tokyo Japanese, supplanting the notions Major Phrase and Minor Phrase, or Intermediate Phrase and Accentual Phrase, which are exploited in standard works in this area. Moreover, based on findings concerning the distribution of default pitch accents in Connemara Irish, Elfner (2012, 2015) argues for the inclusion of the notion $\varphi_{non-min}$ in the repertoire of recursion-based prosodic subcategories. In three of the papers in this issue, recursion-based subcategories of φ are argued to play a crucial role in the phonology or phonetics of the language examined: Kügler argues that

phrasal regressive ATR harmony in Akan is blocked at the edge of φ_{max}, Elordieta argues that in Lekeitio Basque partial pitch reset is found at the left edge of $\varphi_{non-min}$ and O'Connor & Patin suggest that default H tone is assigned to the penultimate syllable of a φ_{min} in a dialect of Shingazidja. So, just as languages may differ in whether some phonological or phonetic phenomenon is defined with respect to constituents of the basic prosodic categories ι, φ and ω, the same sorts of phenomena may, depending on the language, be defined with respect to constituent types that are their recursion-based subcategories.

If phonological markedness constraints refer to prosodic (sub)categories, which may be thought of as the node labels of a PrStruc-bracketing or tree, do they also refer to other aspects of the tree structure or bracketing? Is reference to recursion in the statement of phonological constraints on prosodic structure limited to that embodied in recursion-based prosodic subcategories? Are any other sorts of domination or sisterhood relations relevant to the theory of PrStruc-sensitivity? Clearly, in seeking to answer these questions, the theory of reference to tree or bracketing structure that one would want to entertain at the outset should be extremely restrictive, while consistent with known facts, with predictions that could readily be shown to be false. In this spirit of restrictiveness, let us entertain the hypothesis that the structure-sensitivity expressed in any phonological markedness constraint that relates featural representation to prosodic constituency is absolutely minimal, including (a) reference to only a single constituent of a specified prosodic category of type π, and (b) reference to the relevant tonal or segmental feature properties associated with the terminal string of the representation. In such a theory, a PrStruc-sensitive phonological markedness constraint could have structural descriptions of the schematic forms in (1a) or (1b).

(1) a. *'Domain-span' rule/constraint*
        $(... \psi ...)_\pi$
     b. *'Domain-edge' rule/constraint*
        i. $... \chi (\psi ...)_\pi$
        ii. $(... \psi)_\pi \chi ...$

The symbols ψ and χ stand for sequences (possibly null) of properties of the terminal string that are mentioned in the constraint; these may include segmental features, tonal features, representation of tonal associations and mora structure. The notation '$(...)_\pi$' is not part of the terminal string; it is part of the prosodic labelled bracketing, and refers to the left and right edges of a hierarchical prosodic constituent π which is represented in the prosodic tree structure of the sentence. The prosodic category or subcategory label π provides the only information in the statement of the constraint about the position of the string $\chi\psi$ in the hierarchical organisation of the phonological representation.

A constraint with a structural description of type (1a) can express a restriction on the co-occurrence of two or more elements of the terminal

string that holds only within a prosodic constituent of a particular type, say ω, but not on any higher-level constituent in the representation, as with an OCP restriction against a sequence of H tones only within the same ω. Structural descriptions like (1b) can figure in constraints that call for the positioning of a tonal feature on the rightmost, or leftmost, TBU within a prosodic constituent π, and can figure in principles of phonetic interpretation involving pitch or duration, for example, which come into play at constituent edges. Consider next constraints on the spreading of features, which we assume involve multiply linked representations. Itô & Mester (1999) propose a family of CRISPEDGE constraints that disallow multiple linking to elements that flank the edge of some prosodic constituent π. In this conception, the markedness constraint that calls for multiple linking in the first place is not itself confined to a constituent π, with a structural description of type (1a). Rather the constraint calling for multiple linking can be construed as free, but potentially in conflict with a distinct markedness constraint of the CRISPEDGE family that prohibits multiple linking across a specified edge of π. CRISPEDGE constraints can be expressed with the structural descriptions of (1b), depending on whether the blocking is at the left or right edge of π. Selkirk (2011) analyses a restriction on rightward H-tone spreading in the Bantu language Xitsonga in these terms, based on data from Kisseberth (1994): for example, the rightward spreading of a H tone originating in a verbal complex that prosodically constitutes a ω is blocked from continuing through the left edge of a following adjacent φ corresponding to the direct object by a CRISPEDGE-L(H, φ) constraint, with the format in (1b.i). This CRISPEDGE constraint imposes what is in effect a prosodic constituency-based adjacency constraint: 'assign a violation mark when a H tone linked to a φ-initial TBU is linked to a TBU that precedes φ'.

The question whether the specification of just a single π-type constituent as in (1) does indeed allow for a theory of structure-sensitivity in phonological markedness constraints that insightfully characterises the instances of structure-sensitivity observed cross-linguistically should be kept in mind in reading the papers in this thematic issue. This single-constituent theory of possible reference to prosodic domains in constraints allows reference to a single paired bracketing corresponding to a π, but excludes reference to any further π structure, other than that implied when π is a recursion-based subcategory, and it excludes reference to multiple levels of prosodic category (π_1, π_2, etc.). It therefore excludes the class of domain-juncture rules/constraints posited by Selkirk (1980), while allowing for the domain-span and domain-edge classes, reintroduced above as (1). The domain-juncture schema posited in this earlier work is as in (2).

(2) *'Domain-juncture' rule/constraint*
$$(\dots (\dots \chi)_{\pi_2} (\psi \dots)_{\pi_2} \dots)_{\pi_1}$$

A challenge to the single-constituent-based theory of structure-sensitivity presented here is provided by one of the tonal phenomena in Copperbelt Bemba analysed in the paper by Kula & Bickmore, which they claim requires analysis with a domain-juncture constraint. Further investigation is required to see whether there may be alternative analyses that instead assume a single-constituent theory of domain-sensitivity and would succeed in providing equal insight into the Copperbelt Bemba phenomenon.

In sum, the papers in this issue are concerned with phonological and phonetic phenomena whose distribution in the sentence is hypothesised to be a function of the prosodic constituency that organises surface phonological representation. The rules or constraints that characterise the phenomena investigated here make appeal to properties of phonological representation, but not to the morphosyntactic representation that helps determine phonological representation. We may think of these constraints as varieties of PrStruc-sensitive phonological markedness constraints; they are the expression of forces or tendencies that are strictly phonological or phonetic in character. They form a submodule of the larger set of phonological markedness constraints in grammar.

3 Prosodic structure and the organisation of the grammar

A variety of authors have proposed that the stress-prominence assignment and/or the prosodic constituency assignment of PrStruc-formation forms part of the syntactic derivation, in order to explain interaction of syntactic movement with the prosodic phrasing or stress patterns of the sentence, and/or to explain the phrasing or stress patterns themselves. The list includes Bresnan (1971), Cinque (1993), Zubizarreta (1998), Reinhart (2006), Kratzer & Selkirk (2007), Kahnemuyipour (2009), Richards (2010), Samek-Lodovici (2015) and Bennett *et al*. (to appear). In the context of a minimalist execution of this organisational ordering hypothesis, PrStruc-formation could be seen as part of the larger module of phonological Spell-out, which comes into play at the end of each phase or cycle of the syntactic derivation (see Chomsky 1995, 2001, Uriagereka 2012).

Spell-out arguably has a variety of submodules, including: (a) standard 'vocabulary insertion', by which morphosyntactic feature complexes that identify particular words or morphemes are given phonological realisation, (b) linearisation of syntactic constituents, creating surface word order, (c) PrStruc-formation, and perhaps others. The three submodules mentioned have in common that they all involve a direct effect of syntactic representation on phonological form. Importantly, assuming PrStruc-formation as part of cyclic or phasal Spell-out would allow for its interaction with the other submodules of Spell-out. Because of the simultaneity of the operations related to these three submodules, it would be expected that, within a phase, constraints on PrStruc-formation (including prosodic stress prominence) could interact with constraints on linearisation in the sentence. And it would be expected, for example, that the realisation of

allomorphs of particular morphosyntactic feature complexes would depend not only on syntactic structure but also on position in a larger prosodic structure (cf. Mascaró 1996), or that haplological non-realisation of one of two function words in sequence would depend on their place in prosodic structure (cf. Golston 1996, Selkirk 2001). Such interactions in Spell-out would provide evidence for placing PrStruc-formation within the syntactic derivation.

But it is not at all clear that PrStruc-sensitive markedness constraints of the phonology belong in the syntactic derivation. This would predict possible cases of opacity in sentence phonology, which to our knowledge are unattested. Moreover, the notion that the phonetic interpretation of the sentence proceeds derivationally, by phase or cycle, goes counter to the common understanding of phonetic interpretation as proceeding temporally, from the beginning to the end of the sentence. Instead, it seems desirable to construe PrStruc-sensitive sentence phonology and phonetics as post-syntactic (post-derivational, post-cyclic, post-phasal, etc.), in effect 'waiting' until the formation of the full sentence is complete. In the minimalist model, all linearisation of syntactic terminals is complete at the end of the syntactic derivation, and SStruc-representation is no longer accessible. The now-surface prosodic structure in the phonological representation of the sentence provides the only available reflex of syntactic constituency. Constraints of post-derivational – i.e. post-syntactic – phonology would have access only to primitives of phonological representation, including prosodic constituents and prosodic prominence, and the same would be true for the phonetics. Placing all general, non-morpheme-specific but constituency-sensitive, phonology (and phonetics) in a position in the grammatical architecture where syntactic structure is absent has the consequence that the relation of these phenomena to syntactic constituency is of necessity indirect, mediated by the grammar of PrStruc-formation. Of course, it remains to be seen if the data do indeed support a post-syntactic position for PrStruc-sensitive phonological markedness constraints and phonetic interpretation in the architecture of the grammar. This is one of the many questions for future research that this introduction has sought to identify.

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