15. Syntax–phonology Interface

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0 Introduction

How are the synatactic and phonological components of the grammar organized with respect to each other? Are these components independent, or do they exert mutual influence in at least some ways? The syntax–phonology interface has a solid empirical basis, documented in a large body of literature (recent collections include *Phonology Yearbook* 4 and Inkelas and Zec 1990). The primary source of evidence is provided by phonological rules that operate over syntactically defined domains, showing that constituency in one component (syntax) is relevant to the processes in another (phonology). But interactions between syntax and phonology have also been manifested in the opposite direction: constraints that are phonological in nature may be relevant to syntactic processes.

In this article, we review old arguments and present new evidence for the different facets of syntax–phonology interaction. We focus on the bidirectionality of the influence of these two components upon each other, taking this property as a basis for proposing what we believe to be the most appropriate representation for this kind of interaction across the components of the grammar. The article is organized as follows: section 1 examines the nature of phonological rule domains generally; sections 2 and 3 discuss syntactic and prosodic constraints, respectively, on phonological phrases, and section 4 evaluates the evidence that phonological phrasing requirements may also constrain syntax. Probable directions of future research in the syntax–phonology connection are presented in section 5.

1 The Nature of p-structure

Evidence for the syntax–phonology interface comes from the numerous cases of phonological rules with syntactically conditioned environments. Observe the functioning of Raddoppiamento Sintattico, a well-known phonological rule of gemination applying over syntactic domains in Italian (Nespor and Vogel 1982, 1986):

> (1) Raddoppiamento Sintattico (RS): In a sequence of two words w_1 and w_2, the initial consonant of w_2 geminates if w_1 ends in a stressed vowel, and if certain syntactic conditions are met.

A simple example is given in (2), and some of the intricate syntactic conditioning is illustrated in (3)–(5).[1] The application of Raddoppiamento Sintattico is indicated by bracketing the geminated segment; failure of RS is indicated with double slashes. All examples are taken from Nespor and Vogel 1982, p. 228, 1986, pp. 38, 170.

> (2) Parlo [b;]ene “He spoke well”
>
> (3) Devi comprare delle [mappe [di citta [v;]ecchie $]_{pp}$ $]_{NP}$ “You must buy some maps of old

cities"

(4) Devi comprare delle [mappe [di citta]$_{PP}$/ vecchie]$_{NP}$ "You must buy some old maps of cities"

(5) Devi comprare delle [mappe [di citta / molto vecchie]$_{PP}$]$_{NP}$ "You must buy some maps of very old cities"

Note that Raddoppiamento Sintattico applies across certain syntactic junctures but not across other. It applies between a verb and an adverb in (2), and between a noun and an adjective in (3). It fails to apply between adjacent words that satisfy the phonological condition but are not immediate syntactic constituents, such as *citta* and *vecchie* in (4) or *citta* and *molto* in (5).

The essential question raised by data of this type is which aspects of syntactic structure are systematically called upon in characterizing the environments of phonological processes. Each of the following features of syntactic phrase structure has been considered necessary for this purpose (and some researchers have proposed more than one of them). References are necessarily incomplete:

(6) (a) Phrasal rank, or bar level, as proposed in Chomsky and Halle 1968 (henceforth *SPE*) and subsequent work in the same framework (Selkirk 1972, 1974; Rotenberg 1978), as well as in later work (e.g., Selkirk 1986; Selkirk and Shen 1990)
(b)the head/complement relation (Nespor and Vogel 1982, 1986; Hayes 1989b)
(c)syntactic sisterhood (Zec and Inkelas 1990)

Certain other aspects of the syntactic constituency, such as syntactic category or the morphological specifications of terminal elements, appear to be irrelevant for the purposes of phonology and, in a sufficiently constrained theory, the phonological component should not be able to access them.

1.1 The Characterization of Rule Domains

One possible approach to characterizing phonological rule domains is that taken by Kaisse (1983, 1985a): phonology may access the syntactic component directly, and syntactically conditioned phonological rules are governed by known syntactic relations such as c-command and edge membership (Kaisse 1985a, p. 155). It has become a majority view among researchers in this area, however, that syntax does not provide domains for phonological rules in a direct fashion. Both the impoverished amount of syntactic information needed by the phonological module and the variety of mismatches between phonological rule domains and syntactic constituency argue for positing another level of representation (Selkirk 1978, 1980a; Nespor and Vogel 1986).[2] In the following section we focus on the justification of this additional level; we will refer to this prosodic level as p-structure and to the corresponding syntactic constituency as s-structure. P-structure mediates between the syntactic and the phonological modules, and serves as the locus of their interaction.

1.2 Bounaary Symbols

An early version of p-structure was proposed in *SPE* and developed in subsequent work (Selkirk 1972, 1974; Rotenberg 1978). According to this view, domains of phonological rules are expressed in terms of phonological boundary symbols, generated by rules such as the following (*SPE*, p. 366):

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

The only syntactic property relevant for this version of p-structure is phrasal rank, or bar level, which maps into boundary symbols. Boundary strength is quantitative, expressed by the number of boundary symbols present. A given phonological rule specifies only the minimal boundary strength across which it cannot apply - or, alternatively, the maximal boundary strength across which it does apply.

Under the *SPE* view, boundary symbols alone express constituency at the level of p-structure. But

boundary symbols form a constituency only in the weakest sense, precluding any systematic statement of the range of possible domains for phonological processes. (For a summary of criticisms of boundary symbols, see Selkirk 1980a and Hayes 1989b). Moreover, as elements of the phonological representation, boundary symbols are subject to powerful restructuring processes in the *SPE* framework. Deleting boundary symbols has the effect of reducing boundary strength; inserting boundary symbols strengthens a boundary. The capability for adjustments of this kind diminishes even further the predictive power of the boundary symbol theory of p-structure.

1.3 Prosodic Structure

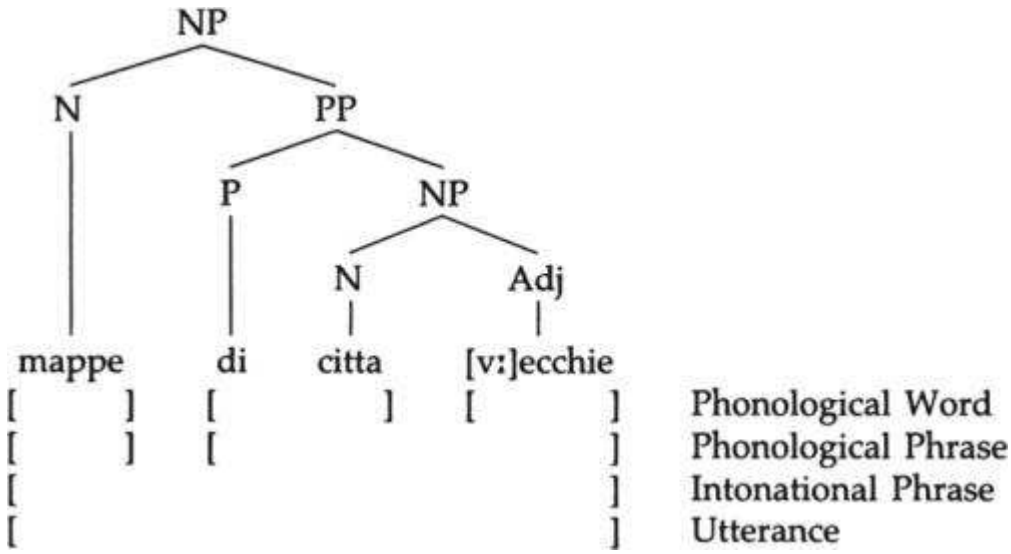
Far more constrained is the "prosodic" view of p-structure. Under this view, p-structure occupies a level with its own hierarchical organization and a high degree of autonomy. The constituency at p-structure is distinct from that at s-structure; though the two constituencies are related to each other, they are not isomorphic. As initially proposed by Selkirk (1978, 1980a), and further developed by Nespor and Vogel (1982, 1986) and Hayes (1989b), p-structure is composed of the specific hierarchy of prosodic constituents in (8):[3]

(8) phonological word
phonological phrase
intonational phrase
utterance

Each phonological rule applies within a selected prosodic domain, which explains why certain syntactic junctures are too strong for a rule to apply over while others are not. The former, but not the latter, correspond to the boundaries of prosodic constituents.

As an illustration, the noun phrase from (3) is reproduced below, with both s-structure (above) and p-structure (below) represented:

(9)



The rule of Raddoppiamento Sintattico applies within the phonological phrase, and as shown in (9), the juncture at which the rule applies in this specific case is internal in a phonological phrase.

In the next section we look at the relationship of s-structure and p-structure, focusing first on different characterizations of the phonological phrase, and then on the phonological word.

2 The Impact of s-structure on p-structure

The two smaller domains in the Prosodic Hierarchy,[4] namely the phonological word and the phonological phrase, have been studied in a variety of languages, and the results are quite encouraging. The morpho-syntactic characterizations of these two domains exhibit impressive cross-linguistic similarities; moreover, the attested range of variation appears sufficiently small to be viewed as parametric in nature (see Nespor and Vogel 1986; *Phonology Yearbook 4;* Inkelas and Zec 1990; Zec 1993). Unfortunately, this cannot be said of the larger domains. While the intonational phrase is viewed by some researchers as directly related to s-structure (Rice 1987), others, such as Selkirk (1984b) and Vogel and Kenesei (1990), question this assumption and assume a more semantic or even pragmatic role for intonational phrasing. In this overview we focus on the phonological word and phonological phrase, whose origins are uncontroversially morphosyntactic in nature.

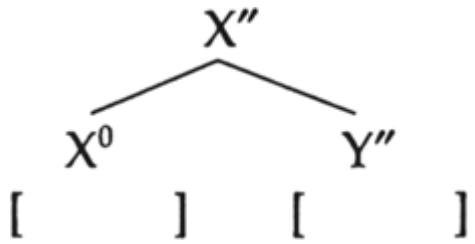
Researchers differ as to which of the properties of s-structure are mapped into p-structure, and which are excluded from this mapping. We compare three proposals of mappings between s-structure and p-structure:[5]

(10) (a)relation-based mapping (e.g., Nespor and Vogel 1982, 1986; Hayes 1989b)
(b) end-based mapping (e.g., Chen 1987; Selkirk 1986; Selkirk and Shen 1990)
(c) arboreal mapping (Zec and Inkelas 1990)

2.1 Relation-based Mapping

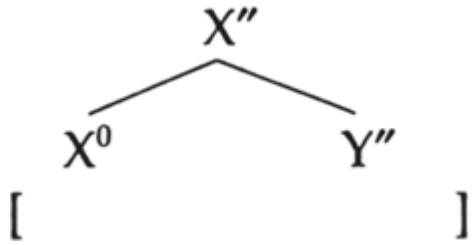
Relation-based mapping algorithms make a crucial distinction between heads and complements of syntactic constituents. According to Nespor and Vogel (1986) and Hayes (1989b), the mappings in (11)–(13) give the range of possibilities predicted under this view. The first possibility is that the head and the complement obligatorily map into separate phonological phrases, as shown in (11).

(11)



A second option is for the head and complement to map into a single phonological phrase, as shown in (12).

(12)



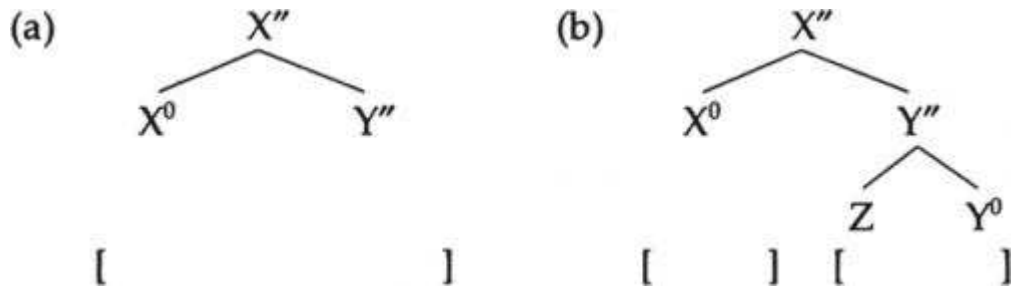
The first case is illustrated by Chi Mwi:ni (Kisseberth and Abasheikh 1974), in which a stress assignment rule makes reference to phonological phrases of the type characterized in (11) (Hayes 1989b; Nespor and Vogel 1986; Selkirk 1986). The second case is illustrated by French. One type of liaison, which operates in colloquial French, applies within phonological phrases as characterized in

(12) (Nespor and Vogel 1986; Selkirk 1986; de Jong 1990b).

While these examples have involved head-initial languages, relation-based mapping is equally applicable to head-final languages, which exhibit the same range of possibilities. The only difference is that the relevant s-structure constituencies are a mirror-image of those in (11)-(13). The mirror-image of (11) is illustrated by Japanese (Poser 1984b; Nespor and Vogel 1986; Selkirk 1986), and the mirror image of (12), by Korean (Cho 1990b).

A complication for this mapping algorithm is posed by languages such as English and Hausa (Zec and Inkelas 1990) and Kinyambo (Bickmore 1990). In these languages, the complement and head phrase together whenever the complement is nonbranching (13a), and otherwise phrase separately (b):

(13)



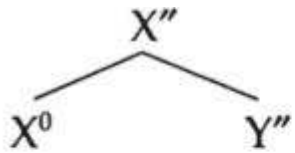
Italian presents a mixed type, instantiating either the situation in (11) or, as an option, the situation in (13). That is, a nonbranching complement in Italian may optionally compose a single phonological phrase with its head (Nespor and Vogel 1986). To describe languages of the type in (13), the relation-based mapping must thus make reference to the internal structure of complements in addition to the basic head-complement relation.

2.2 End-based Mapping

The end-based mapping of Chen (1987), Selkirk (1986), Selkirk and Shen (1990), and others, attempts to reduce the syntactic sensitivity of the mapping algorithm to a single property of syntactic phrase structure, namely phrasal rank. Mapping algorithms impose phonological phrase junctures at the designated edge (either left or right) of syntactic constituents of a selected rank.

The end-based approach differs from the relation-based approach in that the same set of parameters makes opposite predictions for head-initial and head-final languages. To see this, let us inspect the possibilities for a head-initial language, based on the selection of X", the maximal projection, as the relevant syntactic constituent. As shown in (14), the phrasing of head and complement in a head-initial language depends entirely on whether the right or left edge of X" is selected by the end-based algorithm:

(14)

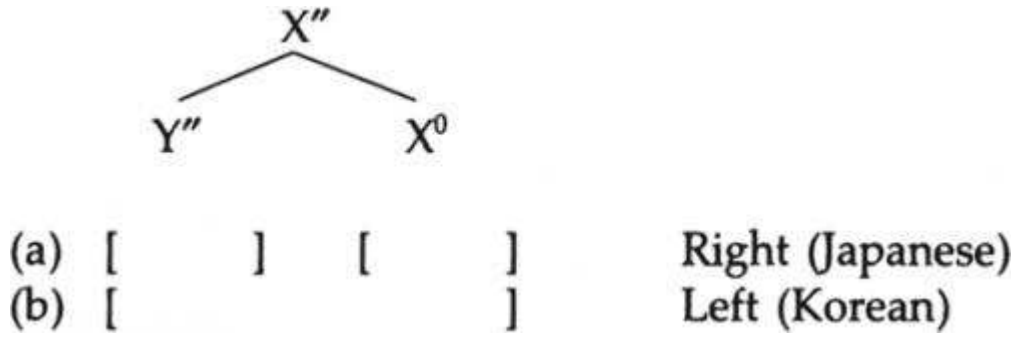


(a) [ ] Right (Chi Mwi:ni)
(b) [ ] [ ] Left (French)

If the right edge is selected, the head and the complement form a single phonological phrase (a); if the left edge is selected, the head and the complement phrase separately (b). These cases (predicted by the relation-based mapping as well) are exemplified by Chi Mwi:ni (Selkirk 1986) and French,[6] respectively.

The opposite correlation between edge-selection and head-complement phrasing occurs in head-final languages. As shown in (15), selection of the right edge of X" causes the head and the complement to phrase separately, while selecting the left edge causes head and complement to form a single phonological phrase:

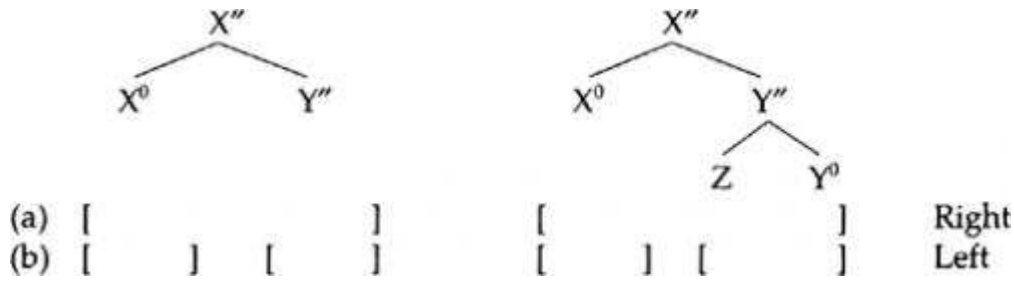
(15)



Examples of the two types of phrasing predicted for head-final languages are Japanese (Poser 1984b) and Korean (Cho 1990b).

As is the case with relation-based algorithms, branching plays no direct role in the algorithm. This creates difficulties for phrasing languages like Italian and English, in which branching complements phrase differently from nonbranching ones. As shown in (16), the end-based algorithm, sensitive only to edges, cannot in its basic form discriminate between simple (a) and complex (b) constituents.

(16)



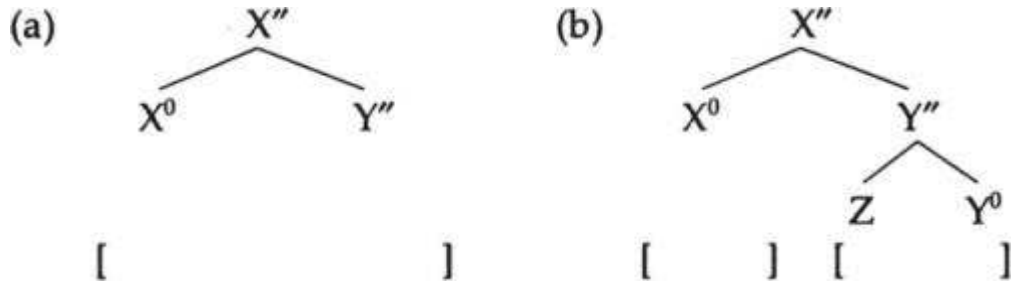
Languages like Italian and English, in which branchingness is relevant to phrasing, require special adaptations of the basic end-based algorithm. Cowper and Rice (1987) and Bickmore (1990) have suggested adding the parameter [+/− branching] to the algorithm. However, as [branching] is not a standard syntactic feature, this move weakens the end-based theory, one of whose main virtues is a highly constrained and principled access to syntactic information.

2.3 Arboreal Mapping

The arboreal mapping proposed in Zec and Inkelas (1990) makes sisterhood, and thus branchingness, a central property in the mapping from s-structure to p-structure. This algorithm groups syntactic sisters into phonological phrases, giving priority to immediate sisters. The effects are illustrated in (17). A non-branching complement, as in (a), cannot form a phrase by itself – as it fails to meet the

sisterhood requirement – and thus phrases with its head, to which it bears a sisterhood relation. By contrast, a branching complement satisifies the sisterhood requirement by itself, forming a phonological phrase of its own. Since no nesting of phonological phrases is permitted – a standard assumption underlying most phrasing algorithms – the head is forced to phrase separately in this case.

(17)



This phrasing is clearly what is needed for languages like English and Hausa. Thus, the arboreal algorithm captures naturally the sensitivity to branchingness which posed problems for both the relation-based and end-based algorithms. By the same token, however, the arboreal algorithm has difficulty handling those cases in which branchingness is not relevant for phrasing. Clearly, in order to account for languages in which complements never phrase with heads – or in which complements always phrase with heads – an arboreal algorithm will have to be made sensitive to the level at which branching is relevant.

2.3.1 Subjects

A distinctive feature of the arboreal algorithm, worth mentioning here, is its treatment of subjects. In its unadulterated form, the arboreal algorithm phrases together any two nonbranching sisters, regardless of syntactic bar level. This has the consequence that a nonbranching subject is predicted to phrase with a nonbranching verb phrase. English data support this prediction, as at least for some speakers, the Rhythm Rule (Liberman and Prince 1977) treats the phrases in (18a) and (b) identically. The Rhythm Rule, whose domain is, for many speakers, the phonological phrase (Nespor and Vogel 1986), retracts the first of two adjacent stresses onto a preceding syllable. Note that stress retraction applies to *Annemarie* in both (18a) and (b). (18a) is a simple noun phrase, which any of the algorithms we have discussed would presumably predict to form a single phonological phrase, while (b) is a whole sentence:

(18) (a) Ánnemarìe's hérd [cf. the isolation form: Ànnemaríe]
(b) Ánnemarìe héard.
(c) Ànnemaríe héard about it already.

Stress retraction does not occur in (18c). This is predictable: the complexity of the verb phrase prevents the arboreal algorithm from phrasing the verb and subject together.

In contrast to the arboreal algorithm, both relation-based and end-based theories predict subjects and verb phrases to phrase separately. Under the relation-based view, subjects are not verbal complements (of the right kind) and should not phrase with verbs. End-based algorithms will also inevitably introduce a phonological phrase margin between subject and verb phrases, which belong to distinct maximal projections. In apparent support of these algorithms, a number of examples are attested in which subjects phrase separately from verb phrases (see, e.g., Hayes 1989b). However, systematic investigation of subjects, or of the effect of subject or predicate complexity on overall sentence phrasing, has yet to be undertaken.

3 Branchingness as a p-structure Property

A recurrent problem for the various syntax–phonology mapping algorithms that have been proposed is the effect of syntactic branchingness on phonological phrasing. Relation-based and end-based algorithms must add special stipulations to their basic set of parameters in order to capture the effects of branchingness, while the arboreal algorithm places undue emphasis on branchingness, at the cost of complicating the description of languages in which internal complexity is irrelevant to phrasing. One promising solution to the problems branching poses for syntax–phonology mapping may be in factoring out the property of branchingness altogether from the syntactic properties known to influence phrasing. Support for this move, which would certainly simplify the syntactic knowledge needed by phrasing algorithms, comes from evidence that the type of branchingness at issue may in fact be prosodic, rather than syntactic.

The first piece of evidence is a widely observed asymmetry in the phonological behavior of content and function words. Only a subset of morphological entities known as words – commonly those that belong to open classes such as nouns, verbs, or adjectives – acquire the status of phonological words (see, e.g., Nespor and Vogel 1986).[7] Those that belong to closed classes, and share at least some properties with grammatical formatives, are not mapped into phonological words. This distinction is in many cases isomorphic with the content/function word distinction (Selkirk 1984b, 1986; Selkirk and Shen 1990; Inkelas 1989). In English, for example, it is well-known that function words such as pronouns and prepositions do not, except in positions of contrastive emphasis, receive the same degree of word stress that content words exhibit (Selkirk 1984b). In addition to accentual asymmetries, function words are known cross-linguistically to be exempt from word-level rules and to violate morpheme structure constraints, including minimal prosodic word size.

The relevance of the function/content word asymmetry for present purposes is its effect on the status of branchingness for phonological phrasing. In English, Rhythm Rule data suggest that phonological phrase formation is sensitive not directly to the syntactic complexity of syntactic constituents, but rather to the number of phonological words present. Example (19) illustrates that a verb phrase made complex by virtue of a function word object – the pronoun in (a) – patterns phonologically with a verb phrase which is syntactically simplex (b). Both phrase phonologically with the preceding (nonbranching) subject and trigger the Rhythm Rule, unlike the verb phrases in (c) and (d) which contain more than one content word and are branching by any measure.

(19)

(a) [Ánnemarìe áte it]$_\phi$
(b) [Ánnemarìe áte]$_\phi$
(c) [Ànnmaríe]$_\phi$ [áte]$_\phi$ [with her fingers]$_\phi$
(d) [Ànnemaríe]$_\phi$ [ate and drank]$_\phi$

This effect strongly suggests that phonological phrasing is sensitive to complexity at the prosodic level. That is, a preferred phonological phrase is one which consists of at least two phonological words:

(20) $[[]_\omega\ []_\omega]_\phi$

An obvious parallel that comes to mind is the minimal size constraint on metrical feet, which minimally have to contain two moras (see, e.g., McCarthy and Prince 1993a):

(21) $[\mu\ \mu]_\phi$

From this perspective, the constraint (20) can be understood as a p-structure-internal requirement on phonological phrases. It is entirely independent of the mapping between s- and p-structure, which makes reference solely to syntactic properties.

4 P-structure Effects on s-structure

We have now conjectured that, in addition to syntactic constraints on s- and p-structure, languages may also impose prosodic (minimal size) constraints on p-structure. This raises the question of the interaction between these conditions. Being independent, the mechanisms may, but need not, act in tandem. Thus we expect to find at least the three types of cases in (22):

(22) (a) Phonological phrases have to branch (constraint (20) always in effect).
(b) Phonological phrases preferably branch (constraint (20) is not an absolute requirement).
(c) Phonological phrases don't have to branch (constraint (20) is not in effect).

Type (22a) is instantiated by English, in which branchingness is strongly enforced, while type (b) characterizes Italian, in which branchingness is preferred but not an absolute requirement. French plausibly belongs to category (c). In French, the preference for branching phrases is so weak or nonexistent that it apparently never causes nonbranching complements to phrase phonologically with heads.

In all of these cases, however, the prosodic branchingness requirement is always weaker than syntactic conditions. For example, in English the requirement that phonological phrases be branching is met only when syntactically possible. If a complement is branching, then its head will phrase separately even though it is nonbranching; this type of "violation" of the branching condition is manifest.

This raises the question of whether languages ever allow the opposite "ranking" between the constraint in (20) and syntactic requirements. In fact, there do appear to be languages, or, rather, specific constructions within languages, in which prosodic requirements have greater force and can even "overrule," so to speak, the syntax. Zec and Inkelas (1990) describe two cases in which syntactic constructions are subject to phonological constraints best described in terms of prosodic branchingness.

In the first example, Serbo-Croatian topicalization is subject to the constraint that the topic must be a branching phonological phrase. Thus, topics consisting of only one phonological word are judged ungrammatical, as in (23b).

(23)

(a)	$[[\text{Taj}]_{\omega}$	$[\text{čovek}]_{\omega}]_{NP}$	voleo-je	Mariju
	that	man	loved-AUX	Mary
	"that man loved Mary"			
(b)	$*[[\text{Petar}]_{\omega}]_{NP}$		voleo-je	Mariju
	Peter		loved-AUX	Mary
	"Peter loved Mary"			
(c)	$[[\text{Petar}]_{\omega}$	$[\text{Petrović}]_{\omega}]_{NP}$	voleo-je	Mariju
	Peter Petrovic		loved-AUX	Mary
	"Peter Petrovic loved Mary"			

Proving that the constraint on topicalization is truly phonological, rather than syntactic in nature, example (23c) shows that a proper name consisting of two phonological words can serve as a syntactic topic, while a proper name consisting of only a single phonological word cannot (b). Zec and Inkelas conclude that the prosodic phrasal branchingness constraint in Serbo-Croatian is sufficiently strong to constrain topicalization.

Similarly, well-known but complicated constraints on Heavy NP Shift in English appear best characterized in prosodic terms. Zec and Inkelas observe that in grammatical Heavy NP Shift constructions, such as that in (24a), the "shifted" noun phrase contains at least two phonological

phrases, while any attempt to shift an NP consisting of only a single phonological phrase is judged ungrammatical (e.g., (b)).

(24)

(a) Mark showed to John [[some letters]$_\phi$ [from Paris]$_\phi$]$_{NP}$
(b) *Mark showed to John [[some letters]$_\phi$]$_{NP}$

Similar effects have been observed by Swingle (1993) for Right Node Raising in English, showing that Heavy NP Shift is not an isolated example.

As Zec and Inkelas observe, the constraint in the Heavy NP construction is not on the branchingness of the phonological phrase. Rather, it appears to be imposed one level higher up in the Prosodic Hierarchy: a dislocated NP must correspond to a prosodically branching intonational phrase.

4.1 The Copresence Model and Phonology-free Syntax

The English and Serbo-Croatian data discussed by Zec and Inkelas suggest that, just as s-structure constrains p-structure, in the familiar form of syntactic constraints on phrasing algorithms, p-structure may affect s-structure as well. Based on this finding, Zec and Inkelas propose a bidirectional model of the syntax-phonology interface. Past theories of the Prosodic Hierarchy have stipulated a unidirectional, even transformational mapping from s-structure to p-structure (see, e.g., Selkirk 1986, p. 373; Vogel and Kenesei 1990); Zec and Inkelas reject this stipulation and assume that the two structures co-exist. This nonderivational "copresence" model enables each level of representation to be constrained by the other.

Though descriptively adequate to handle the observed data, this copresence model violates a well-known principle which Pullum and Zwicky (1988) have named "Phonology-Free Syntax." Intended to account for the absence of syntactic rules (e.g., movement) which refer to segment identity or other details of the phonological string, this principle prevents any access to phonological information by the syntax. In its strong form, the Phonology-Free Syntax rules out even the limited amount of bidirectional syntax-phonology interface observed by Zec and Inkelas.

However, a weaker form of the Phonology-Free Syntax Principle is still consistent with the proposed copresence model. If, as Zec and Inkelas propose, the interactions between syntax and phonology are limited to mutual, local constraints on syntactic and prosodic hierarchical configurations, then syntax will still lack access to segmental information – the undesired interaction emphasized by Pullum and Zwicky.

4.2 How Phonology-free is Phonology-free Syntax?

In practice, the gap between so-called unidirectional theories of the syntax-phonology interface and the bidirectional model proposed by Zec and Inkelas is not as great as it appears. The distinction is blurred by the widespread usage in unidirectional theories of output filters which reject certain syntactic constructions as prosodically ill-formed (see, e.g., Vogel and Kenesei 1990 for specific proposals along these lines to handle data discussed by Zec and Inkelas). For example, the syntax might generate both shifted and nonshifted "Heavy NP" constructions, and a phonological filter could eliminate the prosodically less felicitous of the two.

Although the use of phonological filters of this sort technically maintains the claim that syntax (as a generating component) is insensitive to phonology, it weakens the generalization that syntax (as sentence production) is phonology-free. A theory equipped with such filters still requires the copresence of syntactic and prosodic information, albeit in the phonological component, and thus shares certain basic properties with the outright bidirectional copresence model. The status of output filters will presumably be a topic of continuing debate in the theoretical literature on the syntax-phonology interface.

5 Conclusions

In addition to the issues of mapping and directionality explored above, a number of open questions, both old and new, confront theories of the syntax–phonology interface.

5.1 Consequences of the Prosodic Hierarchy Hypothesis

An important consequence of any theory postulating a single level of p-structure is the predicted convergence among domains of rules in any given language. No matter how many rules exist in a system, Prosodic Hierarchy theory predicts them to utilize a maximum of four domains ("domain clustering"); moreover, those domains must enter into a hierarchical relationship (the "Strict Layer Hypothesis" (Selkirk 1984b).

In making these predictions, the Prosodic Hierarchy Theory distinguishes itself dramatically from so-called direct access theories (e.g., Kaisse 1985a; Odden 1987b, 1990a), in which each individual phonological rule may specify its own unique syntactic conditions. There is no expectation in such theories of any convergence or mutual constraining effect among rule domains.

While the predictions are clear, in practice the evidence is less so. Testing the domain-clustering hypothesis and strict-layering hypotheses has proved difficult because of the small number of (described) postlexical phonological rules applying in subutterance domains in a single language. For example, analyses of English phonological phrases typically draw solely on the Rhythm Rule; Nespor and Vogel base their conclusions about Italian on only one rule in each dialect they discuss. Analysis of several Bantu languages (McHugh 1990; Hyman 1990) has begun to unearth convincing examples of domain convergence, but has also turned up at least one apparent counterexample, in which rule domains intersect (Hyman, Katamba, and Walusimbi 1987). More data is clearly needed before any conclusion can be drawn as to the verity of the domain clustering and strict layering predictions.

One interesting application of, and likely source of further evidence for the Strict Layer Hypothesis is in the so-called "top-down" parsing of the string into prosodic domains. Both Selkirk and Shen (1990) (for Shanghai) and Condoravdi (1990) (for Modern Greek) have observed that phonological phrasing algorithms can be greatly simplified if the syntactic string is first (or simultaneously) parsed into intonational phrases. Since, according to the Strict Layer Hypothesis, each intonational phrase boundary must coincide with a phonological phrase boundary, this sort of "top-down" parsing reduces the work of the phonological phrase algorithm.

5.2 Directions of Future Research

Work on the phonology–syntax interface has emphasized certain languages or families, namely Indo-European, Bantu, Chinese, and Japanese. Much insight will surely be gained from improving the typological coverage of the data base. Particularly illuminating will be the in-depth investigation of non-configurational languages, to which many standard phrasing algorithms are not presently applicable.

Another significant area of research that should inform work on the phonology–syntax connection is the phonology–morphology connection. Preliminary work on highly agglutinating languages has suggested that words, like sentences, may also be parsed into a phonological structure distinct from their morphological structure (Cohn 1989; McDonough 1990; Myers 1992; Halpern 1992; Inkelas forthcoming), and that, as in syntax, prosodic branchingess requirements may restrict morphological operations (Itô and Hankamer 1989; Orgun and Inkelas 1992).

Finally, it is to be hoped that further work on the phonology–syntax interface will increase the usefulness of phonological evidence in determining the syntactic structures of a language. Some work in this direction has yielded fruitful results already in Kiyaka (Kidima 1990) and Korean (Cho 1990b).

1 See Chierchia (1982) for an analysis of the phonological aspects of this rule.

2 See, however, Odden (1987b, 1990) for arguments, based on Kimatuumbi data, against this view and in favor of a "direct syntax" model more like that proposed by Kaisse.

3 It is often assumed (see, e.g., Nespor and Vogel 1986) that the hierarchy of prosodic units extends below the word level to include the metrical constituents of foot and syllable. However, in light of many differences between metrical units and those which function as rule domains, a number of researchers have suggested that the two constituent types belong to separate hierarchies (Selkirk 1986; Zec 1988; Inkelas 1989). For

present purposes we may safely ignore the lower end of the Prosodic Hierarchy, as only the constituents at and above the word level bear any relation to syntactic structure.

4 Nespor and Vogel (1986), following Hayes (1989b), include the clitic group between the phonological word and phonological phrase in the Prosodic Hierarchy. We are asuming here that the clitic group is a specific subtype of one or another of the other constituents in the hierarchy (the phonological word [Selkirk 1986] or even the phonological phrase [Inkelas 1989; Zec and Inkelas 1991]), not a distinct member of the prosodic hierarchy in its own right.

5 The term "mapping" is used here in a neutral sense, covering both a derivational relation, whereby a set of entities is replaced by virtue of mapping with another set, and a redundancy relation, whereby one set of entities is associated with another.

6 According to Selkirk (1986), this domain is characterized as a small phonological phrase derived by an end-based mapping selecting the right edge of each lexical *head* (see de Jong 1990b for a somewhat different analysis along these lines.) However, since French is head-initial, selecting the right edge of X° appears to give the same results as selecting the left edge of X", the analysis we have given French here.

7 These authors technically assign phonological word status to all syntactic terminals, but exempt closed class items, including clitics, from the processes (such as phonological phrasing) to which phonological words are otherwise subject.

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