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Foreword to *Prosodic Domains and External Sandhi Rules*

The present paper was first published 25 years ago, having appeared in 1982 in *The Structure of Phonological Representations*, edited by H. van der Hulst and N. Smith, now out of print.

Why do we consider it worthwhile to republish it? Because, as we all know, articles in books are not read as much as articles in journals, and we think that this paper contains some ideas (later expanded in Nespor – Vogel [1986], to be republished in 2007) that still inspire work that is being carried out today.

One area in which work has continued regards the Phonological Phrase. In particular, much work has followed from claims about the structure of this domain and relative prominence within it, as well as the relation between this domain and the distinction between right and left branching languages. With the exception of one Chinese dialect in which, apparently our generalization does not hold (Selkirk – Shen [1990]), no counterexamples have been proposed in any of the languages examined in the framework of Prosodic Phonology (various papers by Hayes, Itô and Mester, Truckenbrodt, Inkelas, Zec, Booij, Peperkamp, Frota, Vigario, Odden, Kabak, among many others, as well as our own work).

The different phonology reflecting word order in syntax has thus been proposed to be of crucial importance for the acquisition of word order in infancy. If in fact word order could be acquired through prosody, its acquisition may happen before infants have segmented the speech stream and discovered the meaning of words. This would account for the fact that when, at around 20 months of age, children start combining two words, they do not make mistakes in their relative order (Brown [1973]; Bloom [1970]; Meisel [1992]; Clahsen – Eisenbeiss [1993]; Pinker [1994]), and even before then, they appear to use knowledge about word order in comprehension (Hirsh-Pasek – Golinkoff [1996]).

For example, in Nespor – Guasti – Christophe (1996) it is proposed that word order could be acquired on the basis of the location of prominence within Phonological phrases. In Christophe – Nespor – Guasti – van Ooyen (2003), it is shown that 6-12 weeks old infants discriminate Turkish (head final) from French (head initial) solely on the basis of prosody. Hofmann – Höhle –Weissenborn (2003) show that 14-month-old infants, prefer head final to head initial structures, reflecting their first productions. Bion – Höhle – Schmitz (submitted) propose that 14-month-old infants discriminate verb-noun from noun-verb sequences on the

basis of both prosody and morphological markers.

Another area that has continued to receive a great deal of attention is the nature of the Intonational Phrase. Much attention has been devoted to the nature of the relationship between syntax/semantics and prosodic structure (cf. among others Ladd [1986; 1996]; Steedman [1991]; Croft [1995]). While the Intonational Phrase was originally proposed in the present work as a domain for the application of phonological rules, it subsequently became identified as the domain over which intonation contours are spread (*e.g.* Nespor – Vogel [1986]). It is particularly with regard to the intonation contours that the interest in this domain expanded.

Marina Nespor and Irene Vogel

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Prosodic Domains of External Sandhi Rules[*]

1. Introduction

The organization of the phonological component of a generative grammar has changed considerably since the proposal made in *The Sound Pattern of English* (SPE) (Chomsky – Halle [1968]). According to SPE, phonological rules apply to the linear surface structure of a sentence, that is, to the output of the syntactic rules. The phonological and syntactic components of the grammar were thus seen as independent from each other; the phonological rules were blind to syntactic structure. At most, phonological rules could make reference to boundaries in their input strings (cf. Selkirk [1972]; [1974]).

Napoli and Nespor (1979)[1] have shown, however, on the basis of an external sandhi rule in Italian, raddoppiamento sintattico (RS), that there is a much closer relationship between syntax and phonology. Specifically, the facts of RS cannot be accounted for merely in terms of boundaries, but rather seem to reflect syntactic information to a larger extent. That is, phonological rules must be able to distinguish between right and left branches in a syntactic tree. Similarly, Clements (1978) has argued that tone sandhi rules in Ewe cannot be handled by making reference only to boundaries between terminal elements, but rather depend crucially on such notions as left branch, right branch and nonpreterminal node. In these works, while the relation between the syntax and the phonology is viewed in a new light, the traditional view of the hierarchical organization of syntax as opposed to the non-hierarchical representation of the phonology is maintained.

The theory put forth by Liberman (1975) and Liberman and Prince (1977) introduced another significant modification in the organization of phonology. According to their metrical theory, certain (prosodic) aspects of phonology, such as English word and phrase stress, «are not to be referred primarily to the properties of individual segments (or syllables), but rather reflect a hierarchical rhythmic structuring that organizes the syllables, words, and syntactic phrases of a sentence» (*ibid.* 249). This hierarchical structure consists of binary branching trees, and it is to the constituents of such trees that relative prominence is assigned by projection rules. Linguistic rhythm is then seen «in terms of the alignment of linguistic material with a "metrical grid"» (*ibid.*). Vergnaud and Halle (1978) extend Liberman and Prince's proposal, which was based exclusively on English, to an analysis of the stress systems of several languages.

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[*] We would like to thank Jan Edelman, Yukj Kuroda, Anneke Neijt, Donna Jo Napoli, Mauro Scorretti and Milos Stejskal far their helpful suggestions and criticisms. We would also like to thank all of the people who helped us with their intuitions about their native language and in particular Bernard Bichakjian, Emanuela Cresti, Enzo Lo Cascio, Anita de Meijer Concas, Massimo Moneglia and Yuri Okabe. Finally, we are grateful to the many speakers of Italian who spent a lot of time talking into a tape recorder.

[1] NAPOLI – NESPOR (1979) was originally written and circulated as a manuscript in 1976.

They claim that the languages of the world may differ in choosing between the two types of directional trees and the two labelling conventions made available by universal grammar, though they explicitly state that each level of metrical structure consists of uniformly right or left branching trees. What this amounts to is that there are two independent parameters in the stress component, one that establishes the geometry of the tree (right or left branching) and one that establishes the relative prominence of the nodes, that is, their labelling. In a discussion of this proposal, Wheeler (1981) points out that such a system predicts the existence of stress patterns that do not exist in natural languages. To restrict the proposal so that it will not systematically produce patterns that do not exist, Wheeler provides a constraint called the Branching and Prominence Constraint that establishes a correlation between the geometry of the trees and the labelling of their nodes. According to this constraint, right branching trees are labelled w s (weak / strong) and left branching trees s w, independently of whether or not their nodes branch.

While the proposals of Liberman and Prince and of Vergnaud and Halle differ from previous ones in that they introduce a hierarchical structure in the phonology, the relationship between the branching structure of the phonology above the word level and that of the syntax is not clear. Selkirk (1978; 1980a), on the other hand, in addition to accepting the proposal that not only syntactic, but also phonological representations are hierarchical in nature, actually formulates explicit rules for building the phonological categories above the word level. She demonstrates, further more, that certain phonological rules make crucial use of these categories. Thus, while some phonological rules may make reference to labelled bracketings, others make reference to a distinct prosodic structure which includes the following categories: syllable, foot, prosodic word, phonological phrase and utterance. Selkirk points out that, while prosodic and syntactic constituents are not isomorphic, a mapping between the syntactic and prosodic structures can and must be defined, since the prosodic structure reflects syntactic structure in certain ways. The fact that the hierarchical prosodic structure makes use of syntactic information but is not necessarily isomorphic to syntactic structure, is not surprising in that it parallels the situation below the word level, where the phonological and morphosyntactic structures do not necessarily coincide. The mapping conventions Selkirk provides, however, are based solely on English. In this paper, we will investigate further the relation between syntax and prosodic phonology by examining a number of phonological phenomena in Italian and other languages. We propose a series of mapping conventions for Italian which we will then argue are sufficiently general to be able to account for any X-bar type language once the values of certain syntactic parameters have been assigned. Thus we find an illustration of the interpretive role of the phonological component in the sense that the phonology makes use of certain syntactic parameters. That is, at least some aspects of the prosodic

structures found in the languages of the world can be seen as dependent variables, whose value is automatically assigned once the values of certain independent variables (parameters) of the syntax are known.

2. Prosodic structure of Italian

In this section, we will present our analysis of the prosodic structure of Italian based on two suprasegmental phenomena, raddoppiamento sintattico (RS) and intonation contours, and show how this structure allows us to account for additional prosodic phenomena of the language, specifically stress retraction (SR) and the Gorgia Toscana (GT). Since we are particularly interested in the relationship between phonology and syntax, we will limit ourselves to the discussion of prosodic units larger than the word, and thus to those rules that apply above the word level, external sandhi rules, even though we recognize that there is also hierarchical prosodic structure below the word level.

2.1. The phonological phrase: raddoppiamento sintattico

We will begin by considering what is probably the best known external sandhi rule of Italian: raddoppiamento sintattico, the rule which accounts for the lengthening of the initial consonant of $word_2$ in a sequence $word_1$ $word_2$, under certain phonological and syntactic conditions (e.g. *parla [b]ene* ➞ *parla[b:]ene,* 'he spoke well'). While RS is found in all varieties of Central and Southern Italian, the environments for its application vary from region to region. We will restrict our attention here to the Tuscan variety of Italian as spoken in Florence. The phonological conditions for RS in this type of Italian are that $word_1$ must end in a stressed vowel and $word_2$ must begin with a consonant, optionally followed by a liquid or glide, and by a vowel (cf. Vogel [1978]).

While it is clear that RS does not apply between just any two words, predicting exactly where it can occur is a problem which has puzzled scholars of Italian linguistics for years (cf. Camilli [1941]; Fiorelli [1958]; Pratelli [1971], among others). The problem is, in fact, quite complicated since it is not sufficient to know which two words are involved, but it is necessary to know what relationship exists between them. For example, RS occurs between the words *perché* 'why' and *Carlo* in sentence (1a) but not in (1 db).

(1) a. Perché [k:] arlo non è ancora arrivato?
'Why has Carlo not arrived yet?'

b. Che c'è un perché [k]arlo lo sa.
'That there is a reason is known to Carlo.'

As we mentioned above, Napoli and Nespor (1979) have, in fact, shown that without reference to syntax, specifically constituent structure, it is not possible to specify the environments for RS. For example, in a sentence such as

(2) Devi comprare delle mappe di città vecchie.
a. 'You must buy some old maps of cities.'
b. 'You must buy some maps of old cities.'

which can have two meanings corresponding to two different syntactic structures, RS can occur to lengthen the initial consonant of *vecchie* only in the second meaning, that is, only when *vecchie* is a complement of *città*; it cannot occur when *vecchie* is a complement of *mappe*. While Napoli and Nespor's analysis defines those contexts in which RS is allowed, it is incapable of expressing precisely where RS actually occurs. In addition to the syntactic structure, it seemed that the length of the constituents involved, might somehow influence the occurrence of RS, although there was then[2] no part of the grammar that could distinguish between constituents of different lengths. The most recent developments in phonological theory mentioned above, however, suggest that these differences might not be merely a question of length but rather of how constituents of different lengths are organized into prosodic structures.

Data we have gathered on RS[3] have led us to establish the first prosodic category above the word level, the phonological phrase (*ø*). That is, *ø* delimits the domain for the obligatory application of RS; outside of *ø* RS is prohibited. While *ø*'s do not necessarily correspond to syntactic constituents, syntactic information is needed for their construction. In (3) the rules are given for mapping syntactic structure onto the prosodic constituent *ø*.

(3) a. *ø construction.*
Join into a *ø* any lexical head (X) with all items on its non recursive side[4] within the maximal projection and with any other non lexical items on the same side (e.g. prepositions, complementizers, conjunctions, copulas...).
b. *ø constituency*.
ø branches in the same direction as the syntactic trees.

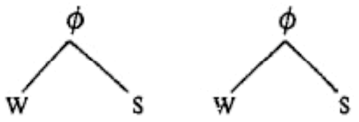
[2] See footnote 1.
[3] The data consist of tape recordings and oscilloscopic measurements of sentences containing contexts for SR spoken by six speakers of standard Italian in Rome, six in Palermo, and five in Florence. The data were gathered as part of a larger project supported in part by the Faculty of Letters of the University of Amsterdam.
[4] By non-recursive side, we mean the side opposite the recursive side.

Since Italian is right branching, ø's are also right branching. Furthermore, assuming Wheeler's proposal that the direction of branching determines the labels of the nodes, each pair of sister nodes is labelled w s.

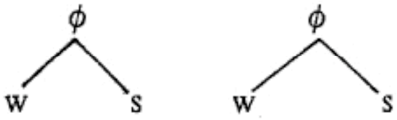
It should be noted that the only items that are considered lexical heads in *ø* construction are N, V and A. Why P does not belong to this group is not entirely clear, since, in some syntactic analyses P is, in fact, considered a lexical category (cf. van Riemsdijk [1978]). It is worth noting, however, that in SPE only N, V and A are considered lexical categories for the purpose of stress assignment. Thus, independently of syntactic reasons for considering P a lexical category, it seems that there are phonological reasons for distinguishing P from other lexical categories.

The application of the rule in (3) is illustrated in the examples in (4). It should be noted that although *ø* is necessary for the specification of the environments for the application of RS, it is not sufficient. In addition, the phonological environment mentioned above must be present in order for RS to apply. Those contexts in which RS actually applies are marked in the examples below by '◡'.

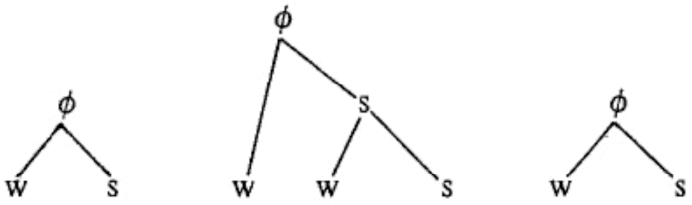
(4)



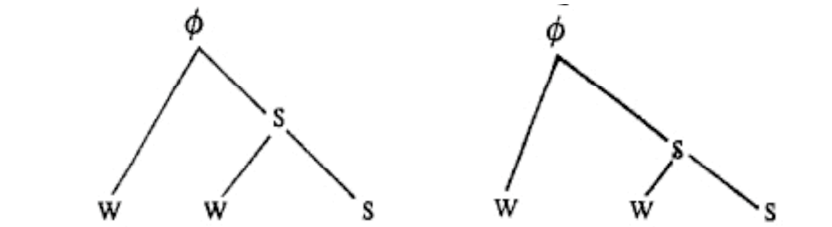
a Ho◡ mangiato da◡ Carla.
'I ate at Carla's.'



b. Ho◡ creduto che◡ venisse.
'I believed that he would come.'



c. 'E◡ passato con tre◡ cani molto belli.
'He passed by with three very beautiful dogs.'



d. Tre famosi quadri sono stati rubati.
'Three famous paintings have been stolen.'

In (4d), we have an example of a Noun Phrase with a prenominal adjective as its complement. Note, though, that in Italian, the position of complements is usually to the right, i.e. recursive, side of the head (cf. 3.1. below). This means that for adjectives the right side is the unmarked position. There are, nevertheless, some cases, as in (4d), in which an adjective can be found to the left, i.e. non-recursive, side of the head; this is the marked case. When they are in the marked position, adjectives do not count as heads of syntactic phrases for the construction of *ø*, but rather are subsumed under a *ø* with the following noun. This particular case may, in fact, be part of a more general principle according to which major categories count as heads for prosody only when they are in the unmarked position. Independent evidence for this characteristic of syntactic phrases has been given by Emonds (1980). To explain the possibility of some extraction transformations and the impossibility of others, Emonds gives the 'Generalized Left Branch Condition', according to which no syntactic phrase C to the left of the lexical head (N, A, V) of a larger phrase is analyzable as C. He also makes explicit that *on the non recursive side* should replace *to the left*.

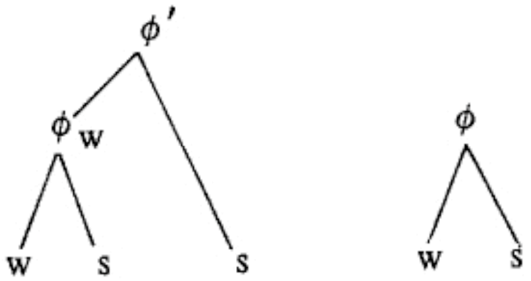
The rule given in (3) to construct *ø*'s, can produce non-branching *ø*'s. To eliminate such *ø*'s, a restructuring rule may apply, which creates a new node *ø'* under certain syntactic conditions. These conditions are given below in (5).

(5) *Optional ø restructuring*.
A non branching *ø* which is the first complement of X on its recursive sides loses its label and is joined to the *ø* containing x under a new node labelled *ø'*.

Note that *ø'* is constructed in such a way that it branches only once. It is therefore impossible to determine its direction of branching. We assume, however, in accordance with Vergnaud and Halle that trees within a stratum, in this case the phonological phrase, are uniformly branching. Thus the relative prominence of the terminal nodes of *ø'* is w s. Illustrations of restructuring are given in (6)-(8), where the forms in *a* are the result of the application of (3) and the forms in *b* are the result of the application of (5).

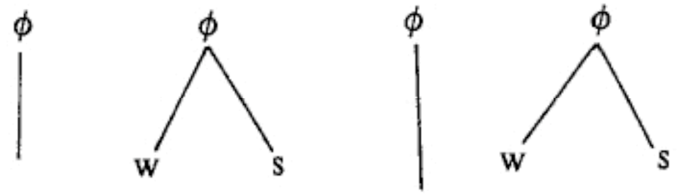
(6)

a. Le città vecchie sono belle.
'Old cities are beautiful'.

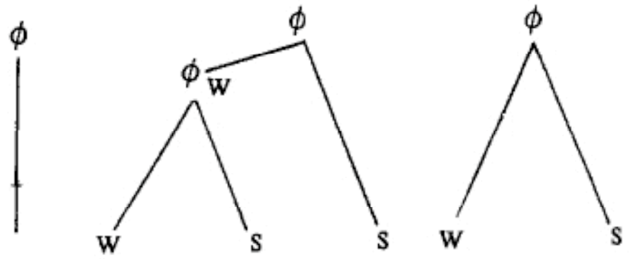


b. Le città vecchie sono belle.

(7)

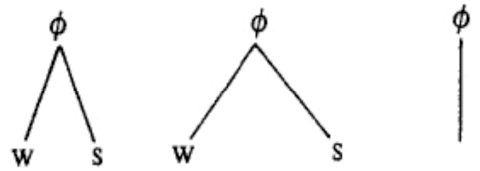


a. Credo che mangerà bene da Francesco.
'I think he'll eat well at Francesco's.'

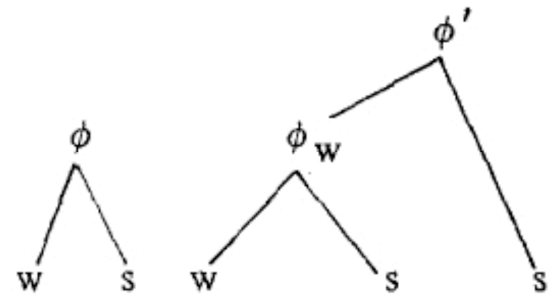


b. Credo che mangerà bene da Francesco.

(8)



a. Non so se troverò Marco.
'I don't know if i'll find Marco.'



b. Non so se troverò Marco.

Since the phonological phrase (*ø/ø'*) is the environment for the application of RS (given the appropriate phonological conditions at the word level and below), when RS occurs between X and a following non branching complement, this is an indication that restructuring has occurred. Note that this restructuring ensures that the rightmost word in a phonological phrase is always marked s. If, on the other hand, RS does not occur in this environment, this is an indication that the non-branching complement forms a separate *ø*. Finally, it should be noted that since *ø* restructuring makes reference to the non-branching nature of the complement of a given head, and thereby "implicitly" to its length, this directly reflects the observation that length plays a crucial role in determining the application of RS as well as other external sandhi rules[5].

2.2. The intonational phrase: intonation contours

Once phonological phrases have been constructed, we can proceed to construct the intonational phrase (I), which consists of one or more *ø/ø'* and is «the domain over which an intonational contour is spread» (Selkirk [1978, 26]). It has often been noticed that syllables at the end of sentences and other types of clauses are lengthened and often followed by a pause (cf. Cooper [1976], among others), and in this way serve to indicate the end of intonational contours. Since performance factors such as rate of speech, style and length of the sentence may affect the

[5] P. Verluyten (personal communication) has suggested that length also plays a role in the application of liaison in French.

number of intonational contours contained in an utterance, any rule for constructing I must allow for this variability. This does not mean, however, that the variability is without limits. Rather, there are certain syntactic factors that play a role in determining the domain of I. Certain syntactic structures, such as parentheticals and non-restrictive relative clauses, obligatorily form I's (cf. Selkirk [1978]). Other syntactic constituents, that is NP and S', determine the grouping of *ø/ø'* into I's, though other non syntactic factors may override these original divisions. We propose the following rules for constructing I:

(9) a. *I construction*.

(i) Any displaced syntactic constituents, parentheticals and non-restrictive relative clauses obligatorily form at least one I.

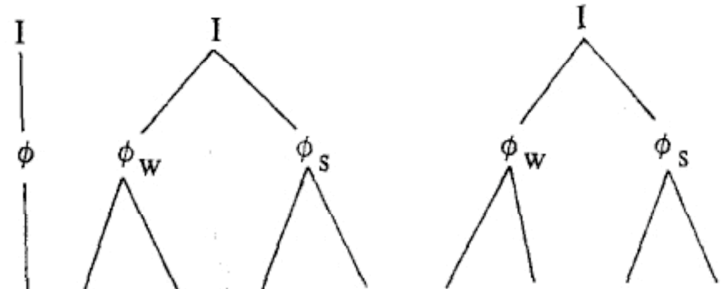
(ii) Starting with the first *ø/ø'* of a sentence, join as many *ø/ø'* as possible into an I until either a) the end of the maximal projection of an N is reached, or b) another S' begins. Once such an I is formed, proceed in the same way until the end of the main sentence is reached. Join any remaining *ø*'s at the end of a sentence into an I.

b. *I constituency*.

I is right branching.

Since I's are right branching, the relative prominence of sister nodes is w s. If we assume that lengthening is typically a feature of strong rather than weak *ø*'s, this accounts for the general observation mentioned above that lengthening tends to mark the ends of intonation contours. That is, in a right branching structure, the strongest element, i.e. the one dominated uniquely by s's, will always be the rightmost one. Since final lengthening appears to be independent of the direction of branching of the syntactic trees, this means that I is right branching not only in Italian but universally. The construction of I is illustrated below.

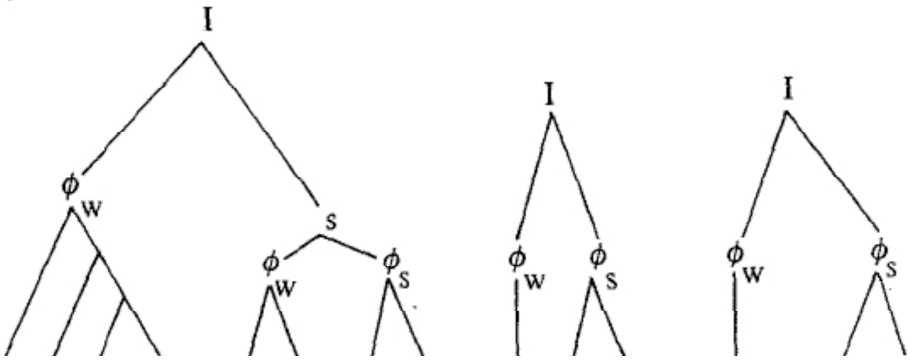
(10)



Marco ha venduto la bicicletta al fratellino di Marta.

'Marco has sold the bicycle to the little brother of Marta.'

(11)



Pur di non andare col padre di Marco, Marta e Alice salterebbero le vacanze.
'Rather than going with Marco's father, Marta and Alice would miss their vacation.'

The I's thus constructed determine the domains over which an intonation contour is spread. Since I is a somewhat variable category, the groupings of *ø/ø'* into I's obtained by the rule in (9) represent only one of the possible divisions. In addition, there are restructuring rules that allow us to modify the original I's in case they are particularly long or particularly short (with the exception of those structures mentioned in (9ai) that obligatorily form I's).

(12) *I restructuring.*

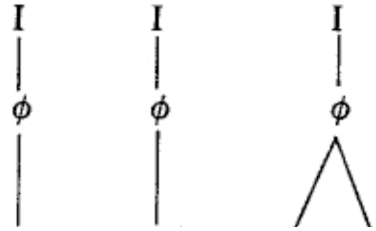
a. Eliminate very short I's by joining them with adjacent I's.

b. Eliminate very long I's by breaking them down into shorter I's.

We have deliberately left the formulation of the restructuring rules vague since we are not yet sure of exactly what factors determine restructuring, and since it seems that these factors include other than strictly linguistic considerations (e.g. physiological limitations, perceptual strategies, stylistic considerations). This is not to say, however, that restructuring is completely random. We have observed, for example, that whenever possible, a restructured I ends with the end of an NP (dominated in this case by other NP's).

When I's are restructured, the previous I structure is eliminated and new I's are built up according to the general branching and prominence convention. The number of I's would be reduced by (12a) and increased by (12b) in the examples given in (13) and (14), respectively.

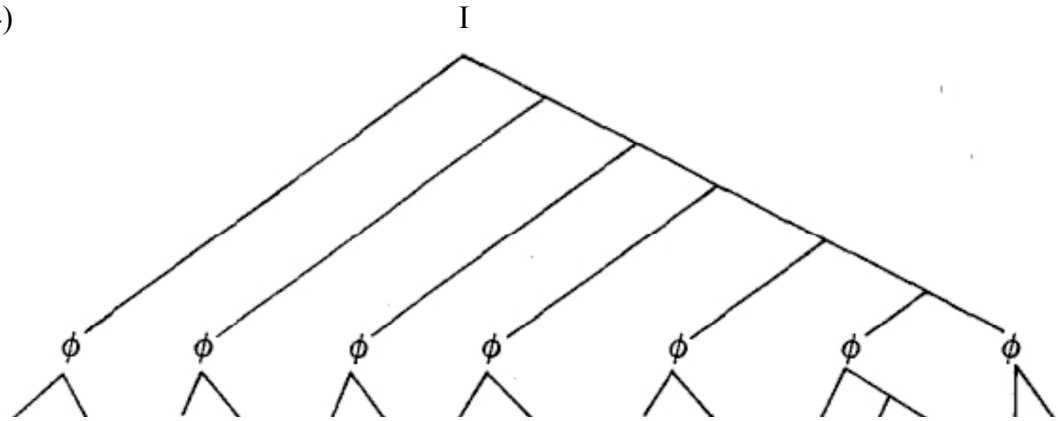
(13)



Marco crede che andrò.

'Marco believes that I'll go.'

(14)



Ha invitato gli amici più cari del fratello più piccolo del suo prof di ginnastica.

'He has invited the dearest friends of the youngest brother of his gym teacher.'

The three I's in (13) may be reduced to two I's by combining the two rightmost I's, or to one I that includes the entire sentence. The single I in (14) may be divided either into two I's such that the first includes the first three *ø*'s and the second the remaining four *ø*'s, or into three I's, such that the first includes the first three *ø*'s, the second the next two *ø*'s and the third the last two *ø*'s.

We have seen above that, apart from constituents that have been moved, the syntactic categories that are crucial in the construction of I are NP and S'. That is, NP and S' barriers for I's[6]. Exactly why this should be the case is not clear to us, though it is interesting that precisely these two nodes are the bounding nodes for subjacency (cf. Rizzi [1980]), and are also barriers for government (see, among others, Bennis – Groos [1980]). They are thus barriers for syntactic, phonological and logical form rules.

Once the I's are built, we can proceed to construct the utterance (U), the highest prosodic category which corresponds to the highest category of syntactic structure (cf. Selkirk [1978]).

[6] They are not absolute barriers since, as we have seen, a restructuring of I can, under certain circumstances, take place with the effect that I can extend over NP and S' (cf. (13)).

(15) a. *U construction*.

Join all I's in a root sentence (most generally the highest category of syntactic structure) into a U.

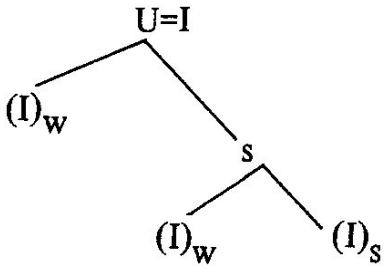
b. *U constituency*.

U is right branching.

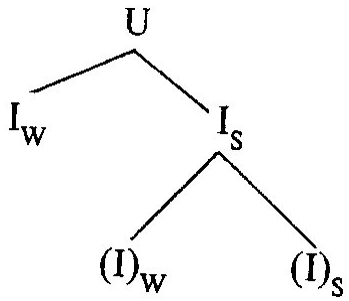
The fact that U is right branching predicts that if, for example, three short I's such as those in (13) are restructured, the first and second I's can be dominated (directly or indirectly) by the same node labelled I only if the third I is also dominated by the same node. The second and third I's, on the other hand, can be joined to form a new I without necessarily including the first I. Either of these possibilities yields an unmarked pronunciation, that is, one with no particular emphasis. The structures in (16a) and (16b) are thus possible while the structure in (16c) is not[7]. The I's in parentheses are those node labels eliminated when restructuring occurs.

(16)

a.

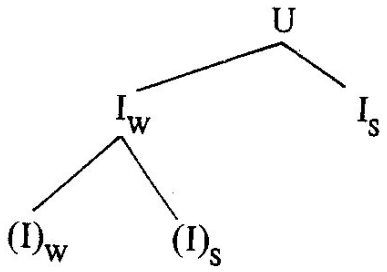


b.



[7] If in sentence (13) special emphasis is placed on the word *crede*, (16c) is the correct structure, as seen by the fact that this word bears the label s only in (16c). The predictions that prosodic trees make in cases of emphasis are very interesting but we will not go into them any further in this paper, since they raise a whole series of independent questions.

c.



The fact that U is right branching means that the rightmost I will always be strong. Since length is one of the features associated with s, the fact that the rightmost I is strong may account for the generally observed lengthening at the end of an utterance. That is, the domain of lengthening will be under I_s, though exactly which elements are lengthened and to what extent, must be determined at a lower prosodic level.

Finally, assuming a model of grammar in which shallow structure, that is surface structures enriched with elements that are not phonetically realized such as PRO and traces (cf. Chomsky [1975]; [1980]) is the input to the phonological component, it is reasonable to ask the following two questions: a) What role, if any, do these elements play in the phonology? b) Assuming that at least some of these elements do play a role, does their influence extend to the entire phonological component or is it restricted to a specific part of it? While it is clear that at least some prosodic rules do not take into consideration the presence of elements without a phonetic form (see, for example, (18b) below in which the Gorgia Toscana applies across a trace), it might be that other prosodic rules are sensitive to such elements (see Jaeggli [1980] who argues that traces marked for case, unlike traces not marked for case, block contraction in English). This is, of course, a very interesting and important problem, but we will not go into it further in this paper.

2.3. Further evidence for ø and I

In this section, we will demonstrate that the prosodic categories established on the basis of RS and intonational contours allow us to account for additional phonological phenomena of Italian: the rule of stress retraction in Northern Italian and the Gorgia Toscana in Tuscan Italian.

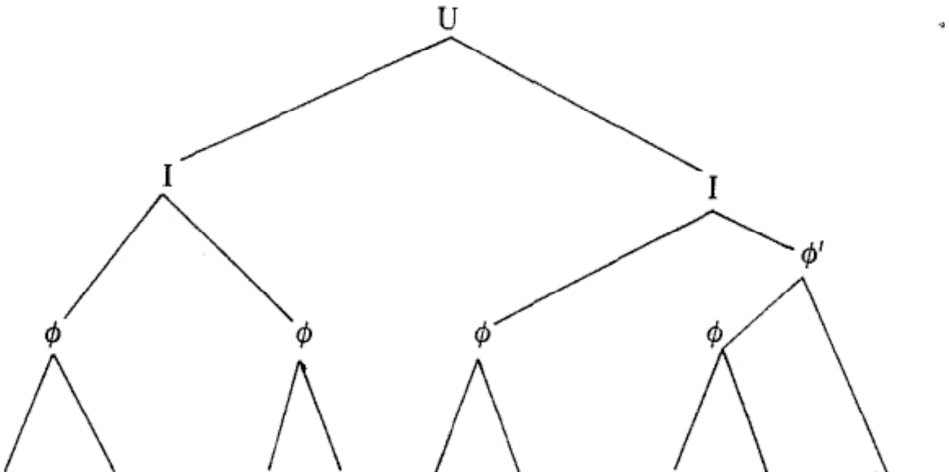
2.3.1. Stress retraction (SR)

SR is a sandhi rule that applies in a sequence of $word_1$ $word_2$, if word ends in a primary stressed vowel and $word_2$ has primary stress on its first syllable. In such cases, the primary stress is moved leftward away from the final syllable of $word_1$ to avoid this clash of primary stresses (e. g.

metà tórta ➞ *méta tòrta* 'half cake').

Nespor and Vogel (1979) have shown that stress retraction is in a type of geographical complementary distribution with RS. That is, the former is found in northern varieties of Standard Italian while the latter is found in central and southern varieties. It follows from this that the prosodic category *ø/ø'*, which defines the syntactic environments for RS also allows us to specify the syntactic environments for stress retraction, despite the difference in the phonological context for the two rules. That is, SR applies, as does RS, only when the two words in question are in the same phonological phrase. The sentence below provides examples of the environments for stress retraction or raddoppiamento sintattico, depending on the variety of Italian in question.

(17)



Ventitré medici del Perú sono stati dalle tribú nordiche.
'Twenty-three doctors of Peru have been to (see) the northern tribes.'

In this sentence there are three pairs of words in which the phonological context for SR (RS) is present: *ventitré medici*, *Perú sono*, *tribú nordiche*. In the first case, SR applies obligatorily since the words in question form a *ø*. SR also applies in the third case if restructuring has applied to form *ø'* as indicated in the prosodic tree. SR is blocked, however, in the second case since the two words belong to different *ø*'s.

2.3.2. Gorgia Toscana (GT)

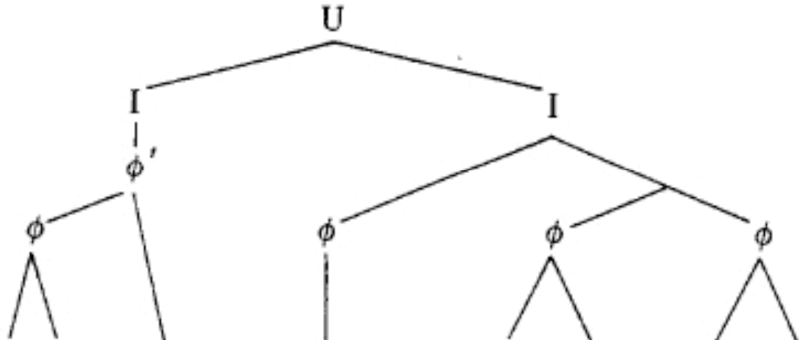
The next sandhi rule we will consider is the Gorgia Toscana. GT is traditionally described as a phonological phenomenon of Tuscan Italian that results in various degrees of so-called aspiration of the voiceless stops *p*, *t*, *k* in intervocalic position (cf. Giannelli – Savoia [1979]; Lepschy – Lepschy [1977]). The most common form of GT changes *p*, t and *k* into ɸ, θ and [h], respectively

(e.g. *la porta* ➞ *la [ɸ]orta* ‘the door’, *la tavola* ➞ *la [θ]avola* ‘the table’, *la casa* ➞ *la[h]asa* ‘the house’).

Since the “aspiration” of k is the most widespread form of GT, we have limited our investigation to this particular phenomenon. On the basis of our recordings of over 900 sentences read by five speakers of Tuscan Italian from Florence and immediately surrounding areas, we have found that the domain of application of GT is I. It should be noted, however, that the Gorgia Toscana, unlike RS and SR, is not exclusively an external sandhi rule, but it applies in I both within and across words, as long as the proper segmental phonological environment exists. Thus, while in the cases of RS and SR, word junctures must be taken into account in addition to the prosodic domain of application, in the case of GT, no further specification is required. The environments for the Gorgia Toscana are illustrated below in (18a), (18b) and (18c).

(18)

a.

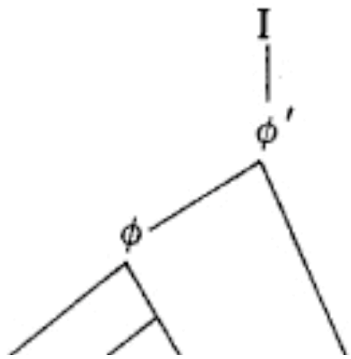


Le case carine costano molto care in America.

‘Cute houses are very expensive in America.’

(– = possible GT; ⫟ = prohibited GT)

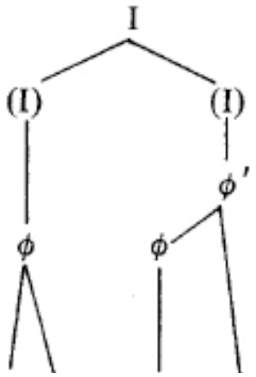
b.



Chi hai visto costì?

‘Who did you see there?’

c.



L' oro costa caro.

'Gold is expensive.'

In the sentence in (18a), GT occurs within the word (cf. *America*), within *ø* (cf. *case*, *care*) and within *ø'* (cf. *carine*), all of which are also obviously within I. GT is prohibited across I's (cf. *costano*), though in the unlikely case that the speaker utters the sentence so quickly that it is a single I, restructuring would then call for GT even in *costano*. In (18b) and (I8c), GT occurs again in *ø'*. Furthermore, in (18c), since the two I's are so short, restructuring is very likely and GT can therefore also occur in *costa*.

3. The universal character of *ø*

In section 2.1., rules for constructing *ø* have been given. It should be noted that, while these rules make reference to the syntactic notion of lexical head, they do not refer to language particular syntactic structures of Italian. Instead, they make reference to the notion of recursive versus non recursive side of a phrase with respect to the head of the phrase. It would be very strange if only Italian prosodic categories needed to refer to such general notions as recursive and non-recursive side of a phrase. In this section we will show that these notions, in fact, allow us to determine the phonological phrase in all X-bar type languages.

3.1. The recursivity parameters

In Graffi (1980), the following two parameters of core grammar are given:

(19) First Parameter of Core Grammar (*ibid.* 379). Every language chooses a recursive side (Chomsky [1965]) with respect to the head of syntactic phrase categories.

(20) Second Parameter of Core Grammar (*ibid.* 382). Some languages only exploit the recursive side with respect to the head: the remaining languages also exploit the non

recursive side[8].

That is, every language chooses a side with respect lo the head for its complements (parameter I) and either the same side or the opposite side for its specifiers (parameter II)[9]. These choices establish what is unmarked in a language, though it is nevertheless possible that some marked orders exist.

If we now look back at our rule for constructing, we see that it depends crucially on which value (right or left) has been assigned to the first parameter of core grammar given above. That is, once the recursive side has been determined, we automatically know that ø will be built on the opposite side of the head. It should be noted that if the second parameter is fixed in favor of the use of the non-recursive side as well as the recursive side, there will be many contexts for construction, whereas if the second parameter is fixed in such a way that only the recursive side is used, the contexts for construction are limited to marked cases if they exist. The fact that the basic syntactic structure of a language is taken into account in constructing implies that ø, rather than being an independent variable of the phonological component, is a dependent variable. This suggests that there are two distinct types of variables in the phonological component: independent variables such as those that specify opaque segments in harmony processes, and variables dependent on the syntax such as those that determine the domain of application of certain rules[10]. This is, of course, an empirical question. What we are saying is that there exists a category of external sandhi rules whose domain of application must be stated in relation to the basic order of the elements in a syntactic phrase. These rules will operate (a) to the left of the head in languages whose recursive side is to the right of the head, (b) to the right of the head in languages whose recursive side is to the left of the head. Furthermore, if there are sandhi rules that apply on the recursive side, this implies that they must also apply on the non-recursive side, but not vice versa. In such cases, the phonological phrase on the recursive side will have been created by a language specific rule. In the next section, we will illustrate the role the phonological phrase, as constructed on the basis of our rules, plays in relation to sandhi rules in languages other than Italian.

3.2. The phonological phrase in other languages

In this section, we will examine sandhi rules in English and French whose domain of application is the phonological phrase. The first rule we will consider is stress retraction in English

[8] Our translation.
[9] This applies of course, only to X-bar type languages, as opposed to W-star type languages. See Hale (1981) for the distinction between X' and W* languages.
[10] Some phonological rules might also need to refer directly to the syntax, such as rules that must specify syntactic categories, but we will not consider this type of rules in this paper.

and the second is liaison in the colloquial style of French. We will also briefly compare Selkirk's (1978) proposal to account for English stress retraction and French liaison since it is, in fact, quite similar to ours. Finally, we will discuss a prediction our *ø* construction rule makes for Japanese.

Rule (3) given above for constructing *ø* yields phonological phrases similar to those yielded by the rule Selkirk (1978) gives for constructing *ø* in English. Our rule is to be preferred, however, since it is more general in that it can *ø*'s in any X-bar type language and since it provides a principled way for determining the direction of branching of the prosodic trees in *ø*.

As Selkirk points out, is the domain of application of the rhythm rule that retracts stress to eliminate clashes of primary stresses, as in *thirtéen mén* ➞ *thírteen mén* (cf. Liberman – Prince [1977] for details of this phenomenon)[11]. In as much as our *ø* is the same as Selkirk's, the two proposals account for the same facts. It seems, however, that an additional category, *ø'* is necessary in English, as in Italian, in order to account for all cases of stress retraction. Consider the following examples.

(21) a. John g1ádly persevéres.
b. John pérseveres gládly.
(22) a. Given the chance, rabbits quickly reprodùce.
b. Given the chance, rabbits réproduce quickly.

While in (21a) and (22a) the verbs *persevere* and *reproduce* have final stress, this is not the case in (21b) and (22b), where they are directly followed by a word with initial primary stress. Thus, it is not the case that retraction occurs only to the left of the head of a phrase. Instead, the domain of application of the rhythm rule in English appears to be identical to the domain of stress retraction in Italian. That is, a restructuring rule such as the one given above in (5) is also required to construct *ø'* in English.

Note that, as in Italian, *ø'* is constructed only when the complement in question is non branching. Thus, retraction occurs as we have seen in (21b) and (22b), but not in the sentence in (23), where the complements are branching.

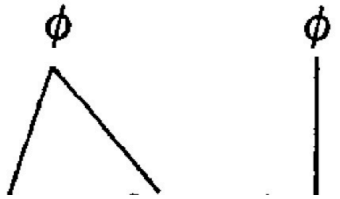
(23) a. John persevéres g1ádly and diligently.
b. Given the chance, rabbits reprodúce véry quickly.

Although Selkirk (1978) does not discuss French in detail, she does mention that the phonological phrase is also the domain of application of liaison. As we mentioned above, the *ø*'s

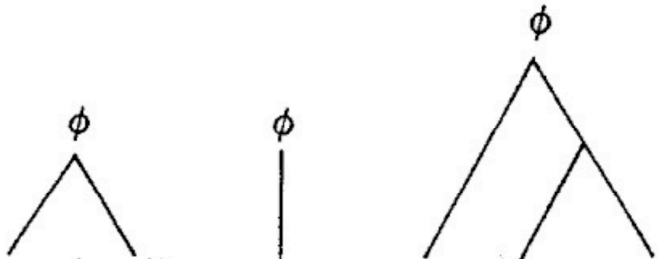
[11] Our use of an acute accent does not say anything about the absolute value of the stress of the syllable bearing it, but simply that it bears more stress with respect to other syllables in the word.

constructed in right branching languages are the same in Selkirk's proposal and the one presented here. It follows, therefore, that both accounts adequately handle liaison. That is, liaison applies in colloquial French within a ø, as illustrated in (24), but not across ø's, as illustrated in (25), where the relevant consonants are underlined.

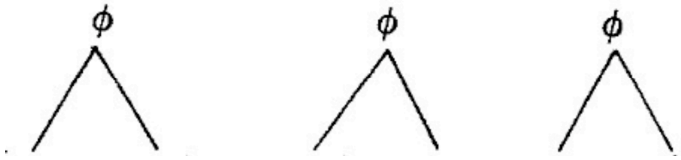
(24)



a. Les enfants chantent.
'The children are singing.'

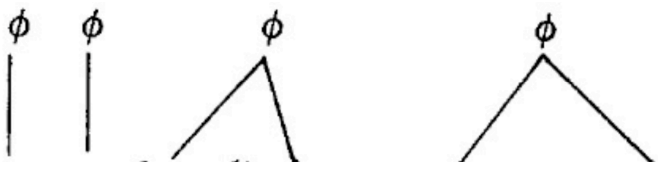


b. Cette famille a trois beaux enfants.
'That family has three beautiful children.'



c. Les enfants sont alles a l'ecole.
'The children went to school'.

(25)



a. Jean a des livres assez nouveaux.
'Jean has some rather new books.'

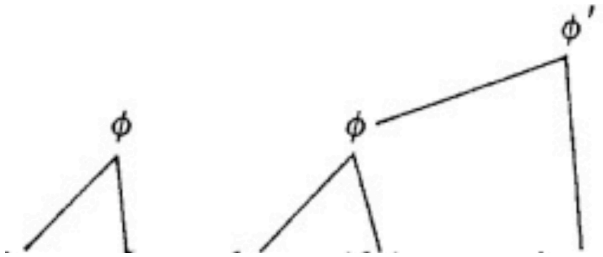
b. Nos voisins avaient deux chiens.
'Our neighbours had two dogs.'

c. Nos invités sont arrivés en retard.
'Our guests arrived late.'

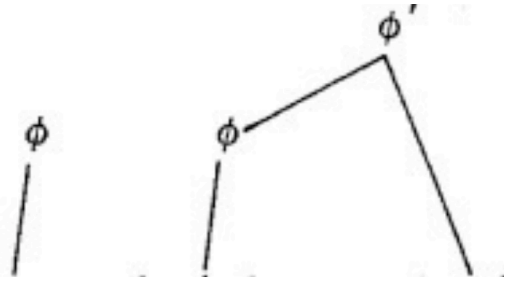
It should be noted, however, that liaison differs from the other rules that operate in the domain of the phonological phrase discussed so far in that it does not apply in the additional *ø'* environment. Thus, while liaison occurs in the sentence above in (24), the *ø* domain, it does not occur in those in (26), the *ø'* domain.

(26)

a. Les maisons italiennes coutent beaucoup.
'Italian house are very expensive.'



b. Les garcons les aidait activement.
'The boys helped them actively.'



c. Marc viendrait aujourd'hui,…
'Marc would come today,…'

This does not necessarily mean that *ø'* does not exist in French. It might in fact turn out that there are other sandhi rules that apply within the domain of *ø'*.

The empirical evidence for the phonological phrase we have given thus far is based on data from right branching languages. We have shown that in these languages external sandhi rules treat everything to the left of the head of a phrase plus the head itself as one constituent (*ø*). The prediction made by our statement of *ø* constituency as formulated in (3b) is that in left branching languages sandhi rules make use of phonological constituents that are the mirror image of *ø*'s in right branching languages. We do not, however, have enough empirical evidence about sandhi rules in left branching languages to make an explicit claim. It is interesting to note, though, that a study by McCawley (1977) of accent in Japanese, a left branching language, seems to confirm the left branching nature of phonological phrases in that language. McCawley claims that if a constituent of more than one word is read «as a single phrase», then it is the accent of the first constituent that predominates, exactly the opposite of what happens in right branching languages. McCawley points out further that a rule that would account for this phenomenon in Japanese is the mirror image of the nuclear stress rule of English (cf. Chomsky – Halle [1968]). Since we have assumed, following Wheeler (1981), that the prominence relation is s w in left branching trees and w s in right branching trees, and since the predominant accent of a constituent cannot fall on a w element, the prosodic category that is the domain of application of the stress rule mentioned by McCawley should be left branching. What remains to be investigated is if that category is *ø* as constructed in (3a), or a category that is the result of a restructuring rule, or still a different category. More data than those provided by McCawley are, however, needed in order to establish the exact environment of the rule.

4. I and U in other languages

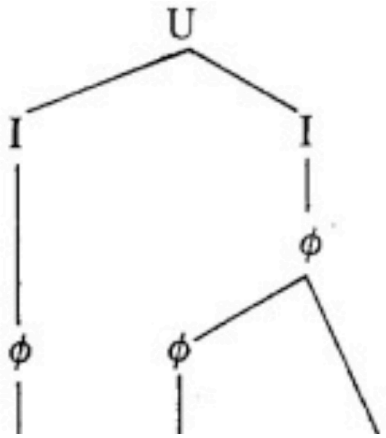
4.1. Intonational Phrase

The rule given in (9ai) for constructing I in Italian is, in fact, quite general in that it makes use

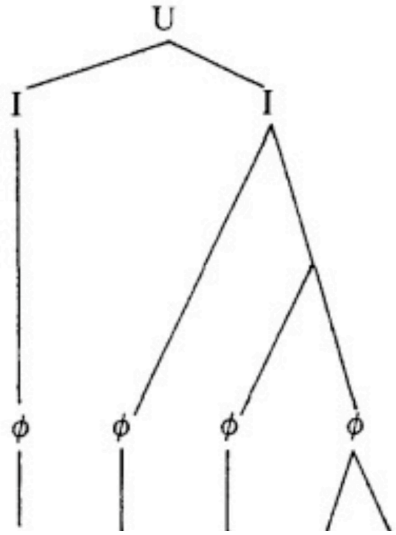
of such notions as displaced syntactic constituents, parentheticals and non-restrictive relative clauses. The part in (9aii), however, makes use of the syntactic categories NP and S' and is thus formulated in such a way that it is a possible rule only for right branching languages. We have suggested above that the fact that NP and S' are relevant for the construction of I might somehow be related to the fact that they are binding nodes for subjacency and barriers for government. We could thus hypothesize that our rule would be adequate for constructing I's in all languages in which NP and S' function in this way. We expect, however, that it would not be difficult to modify the rule to account for other types of languages as well, though in the absence of relevant data, we will not do so here. In the remainder of this section, we will discuss rules in two right branching languages, English and Spanish, that operate in the I domain, as constructed by the rule in (9).

We will first consider the flapping of t and d in American English. It has been noted that flapping not only occurs within words, but also across word boundaries (see, for example, Kahn [1976]). It is obvious that flapping does not occur across all words, but rather it appears to be limited to those within the domain of I. Thus, flapping occurs in the examples in (27), and is blocked in those in (29); the relevant consonants are underlined.

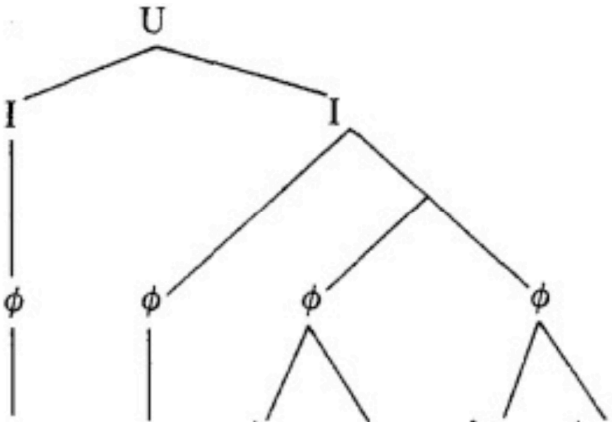
(27)



a. John me<u>t</u> Anne.

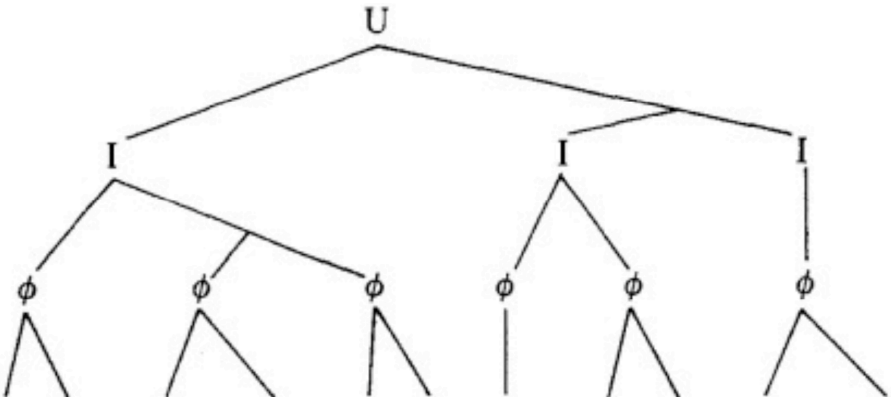


b. John met Anne and Sue.

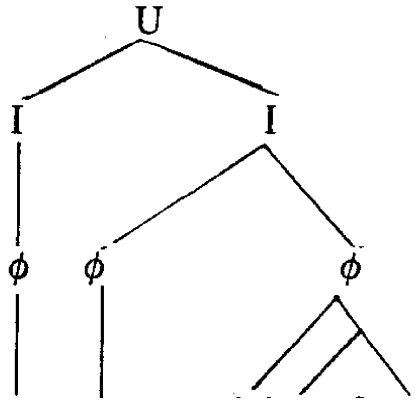


c. John heard the story about Anne.

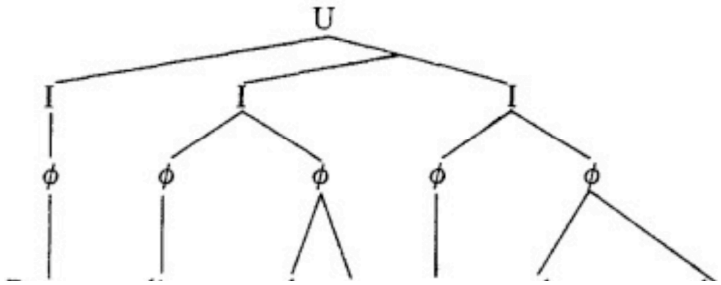
(28)



a. The dean of Admissions at Pratt eats her lunch at MacDonalds.



b. Pat eats with her fingers.



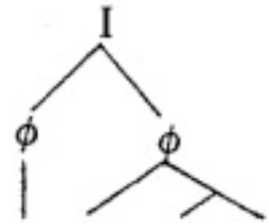
c. Roger, alias the rat, eats only cheese.

While in the examples in (27) flapping is obligatory, since the *t*'s are necessarily within an I, the examples in (28) are slightly more complicated. That is, flapping does not occur because the *t*'s are at the end rather than within an I. As mentioned above, however, restructuring may take place to eliminate sequences of particularly short I's. In (28b), for example, where the first I contains only one word, the sentence is likely to be pronounced as a single intonational phrase. In this case, in fact, flapping occurs. In (28a), since the I's are relatively long, restructuring, and therefore flapping, are highly unlikely, if possible at all. Finally, in (28e), where "alias the rat", a parenthetical, is obligatorily in I, flapping can never occur.

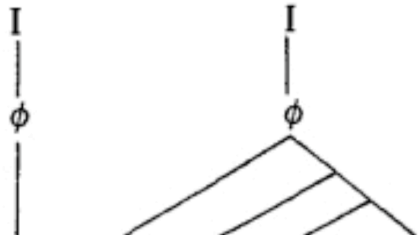
The second sandhi rule operating within I that we will consider is nasal assimilation in Spanish. It has frequently been observed that nasals assimilate in point of articulation to the following consonant across word boundaries as well as within words (cf. Navarro Tomás [1957]; Harris [1968]; Hooper [1976], among others)[12]. Exactly across which words nasals assimilate, however, has never been adequately specified. Examination of the following examples shows that the appropriate domain of nasal assimilation is the intonational phrase constructed exactly as in Italian.

[12] While there are some minor differences in the assimilation patterns within words and across word boundaries, such as the behavior of nasal + glide sequences, we are not concerned with them here.

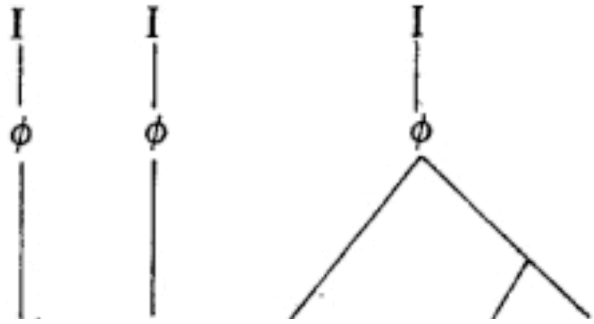
(29)



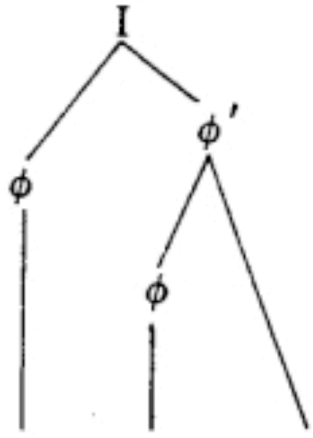
a. Vive en u[m] parque.
'He lives in a park.'



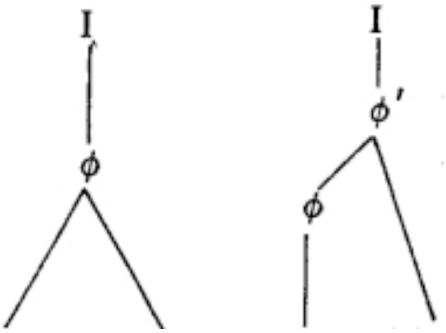
b. Juan es u[m] bue[m] padre.
'Juan is a good father.'



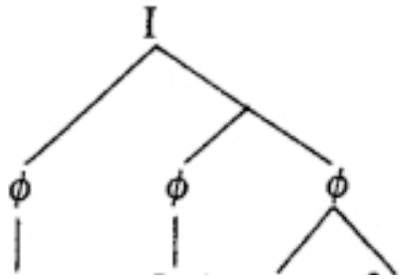
c. Juan sabe que ha[m] bailado.
'Juan know, that they danced.'



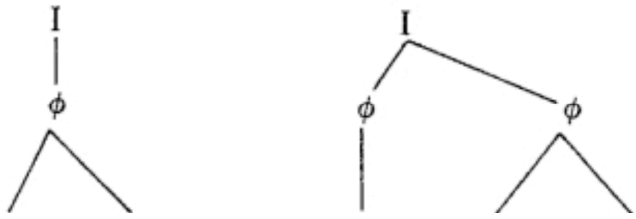
d. Tengo pa[m] bueno.
'I have some nice bread.'



e. Los muchachos canta[m] bien.
'The children sing well.'

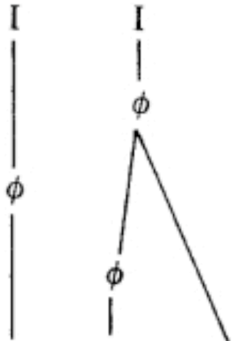


f. Tengo pa[m] poco fresco.
'I have stale bread.'

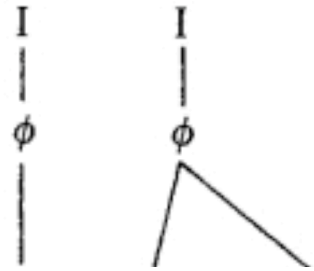


g. Los muchachos canta[m] poco seguido.
'The children don't sing very often.'

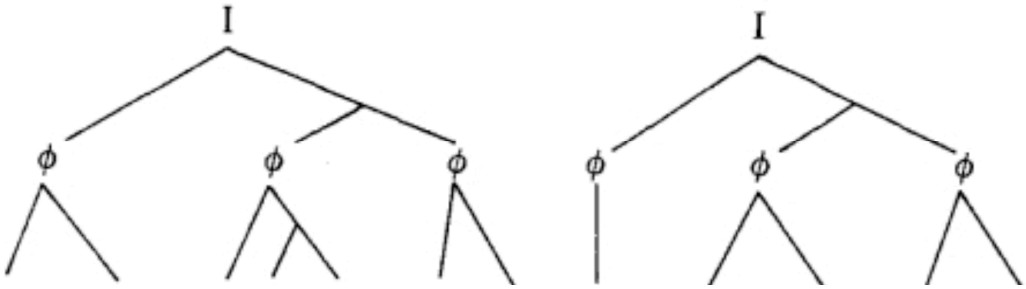
(30)



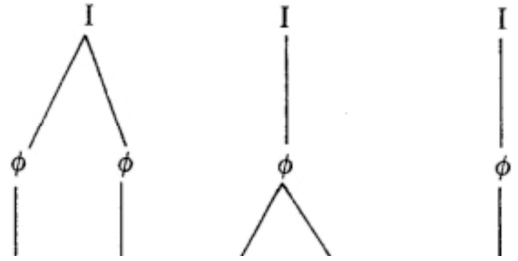
a. Juan baila bien.
'Juan dances well.'



b. Dicen que vienen.
'They say they will come.'



c. El hermano de la mujer de Juan viaja muy seguido con Maria.
'The brother of the wife of Juan travels very often with Maria.'



d. Maria viene, según Juan, mañana.
'Maria comes, according to Juan, tomorrow.'

In the sentences in (29), nasal assimilation applies obligatorily, since all the nasal plus consonant sequences in question are within I. Note, however, that the organization of the relevant words in phonological phrases does not affect the application of nasal assimilation. That is, in (29) *a*, *b* and *c*, assimilation occurs within *ø*, in (29) *d* and *e* within *ø*' and in (29) *f* and *g* across *ø*'s. In the sentences in (30), on the other hand, the nasal and the consonant are in different I's and assimilation, therefore, does not take place. Sentences (30) *a* and *b*, however, are likely to be restructured to avoid very short I's within a sentence, and in this case, assimilation takes place. Such a restructuring is very unlikely in (30c) given the length of the I's, and it is prohibited in (30d) where the parenthetical, *según Juan*, obligatorily forms an I on its own.

4.2. Utterance

We have not yet found any rules in Italian whose domain is U. There are, however, two phenomena in standard English as spoken in England that occur in U: the linking-r and the related, intrusive-r.

While final *r*'s are usually deleted in the English in question, if the following word begins with a vowel, the *r* is retained as a "linking-r". As the sentences in (31) show, the final *r* is retained before any word beginning with a vowel as long as the words are in the same U. That is, the *r* is pronounced within *ø* (31a), across *ø's* within I (31b) across I's (31c) and even at the end of a parenthetical (31d).

(31) a. He has the proper attitude.
b. The ruler of that country is a tyrant.
c. The driver arrived late today.
d. The crime, according to Arthur, is the work of a band of thieves.

When a word ends with a vowel, specifically [ə], [ɔ] or [a], and the next word begins with a vowel, an *r* is introduced, yielding a sequence similar to that produced by the linking-r. The intrusive *r* is also found between any two words in the same U, as well as within words, as we see below.

(32) a. The cat has been claw - r - ing at the furniture all afternoon.
b. I bet you don't dare eat a raw - r - aubergine.
c. They go to America - r - in the spring of every leap year.
d. His far-fetched idea - r - appeals to everyone.
e. The great continent, Asia, - r - evokes mysterious images.

In (32a), the intrusive r is found word internally, in (32b) within a *ø*, in (32c) across *ø*'s within I, in (32d) across I's and in (32e) at the end of a parenthetical.

5. Prosodic Structure and Speech Perception

In this paper we have shown that the grammar, that is, the theory of competence, must include a hierarchically organized prosodic component as part of the phonology. We hypothesize now that the prosodic units justified in the theory of competence are also units of performance, that is, both production and perception. In the remainder of this paper, we will investigate the implications of this hypothesis further, limiting ourselves, however, to perception and further, to Italian data.

Specifically, we will argue that it is the units of the prosodic structure of a sentence that determine the first level of processing in perception. This means that a listener will not be able to distinguish between the possible meanings of ambiguous sentences if they have the same prosodic structure, whether or not their syntactic structure is the same. In order to disambiguate such sentences, the listener must resort to other types of information such as contextual cues.

This proposal makes predictions that contrast with those of Lehiste (1973, 112), among others, according to which sentences that can be disambiguated are ones «for which a difference in meaning is correlated with a difference in surface [syntactic] constituent structure», and sentences that cannot be disambiguated are those that «have only one bracketing, although the constituents may bear different labels». While Lehiste's study deals with English, we do not think this is what accounts for the difference between Lehiste's and our proposals. That is, although the actual syntactic and prosodic structures may differ from language to language, we assume that a principle so fundamental as the role of the different components of the grammar in perception cannot be language specific. The crucial difference lies thus in the fact that Lehiste refers only to syntactic structure while we claim that it is necessary to refer to the prosodic structure, which, although it is based on syntactic structure, is not isomorphic to it.

We will now examine some sentences in Italian which demonstrate that disambiguation in perception depends on prosodic constituents rather than syntactic ones. The relevant sentences are those in which the same sequence of words, can be analyzed syntactically in different ways but which nevertheless yield identical prosodic structure. Consider the sentences in (33) and (34) in which a difference in meaning is correlated with a difference in syntactic structure.

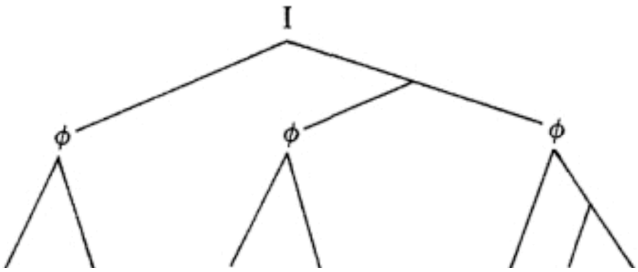
(33) Ha toccato il quadro con la matita.
a. 'He touched the picture with (containing) the pencil.'
b. 'He touched the picture with (using) the pencil.'

(34) Ho mangiato i pasticcini con la cioccolata.
a. 'I ate donuts with (containing) chocolate.
b. 'I ate donuts (together) with chocolate.'

The *a* interpretations in (33) and (34) correspond to the syntactic structures in which the PP is a complement of the NP, while the *b* interpretations correspond to syntactic structures in which the PP is a complement of the VP. Despite these syntactic differences, the prosodic structures corresponding to the different interpretations are identical at the *ø* level. There is, nevertheless, a difference at the I level. The prosodic structures of the *a* and *b* examples are given in (35) and (36)

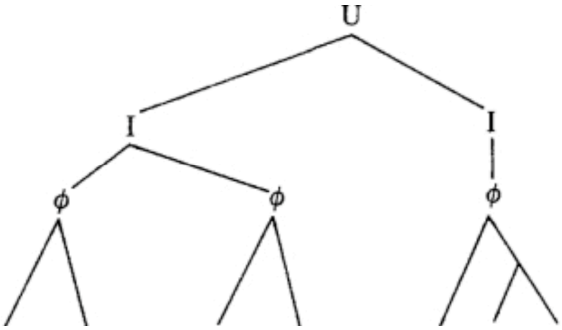
respectively.

(35)



Ha toccato il quadro con la matita.
Ho mangiato i pasticcini con la cioccolata.

(36)



Ha toccato il quadro con la matita.
Ho mangiato i pasticcini con la cioccolata.

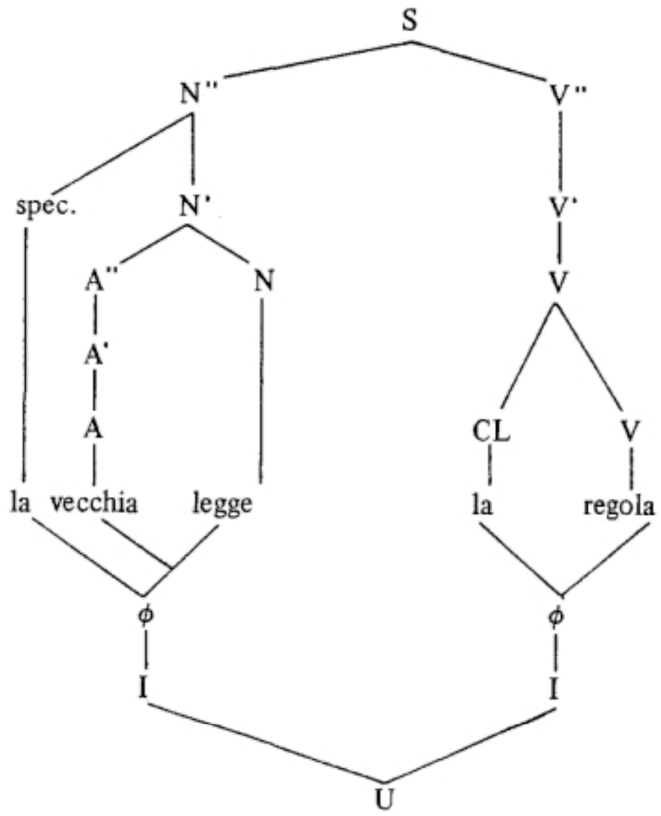
It should be noted, furthermore, that the two I's in (36) may be restructured to form a single I since they are both quite short (cf. (12a)). If this restructuring occurs, as it typically would in such a case, the two sentences can no longer be disambiguated since their prosodic structures become identical, despite their different syntactic structures. If, on the other hand, restructuring does not take place and the sentences in (36) contain two intonational contours, these sentences can only have the interpretations given in (33b) and (34b).

There are other sentences, however, in which different syntactic structures obligatorily give rise to different prosodic structures and may thus be disambiguated on the basis of phonological information, as illustrated by the sentences in (37) and their configurations given in (33b) and (34b).

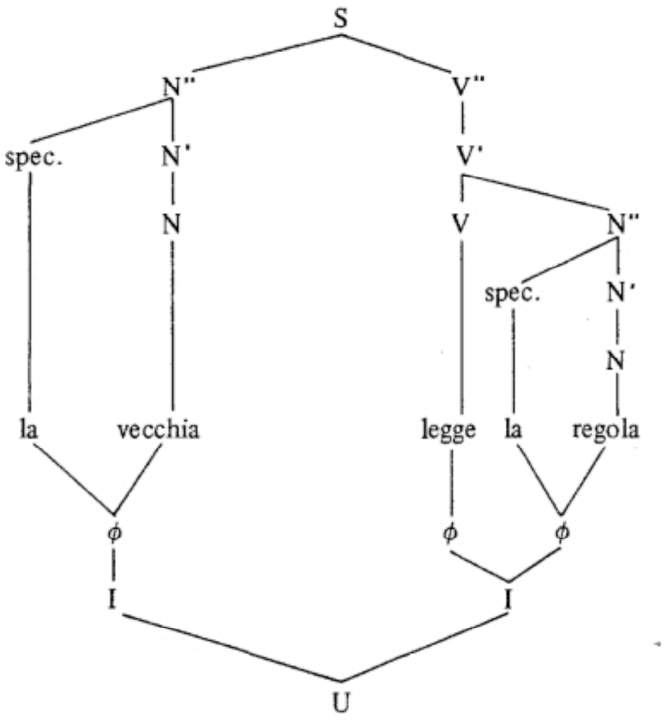
(37) La vecchia legge la regola.
a. 'The old law regulates it.'
b. 'The old lady is reading the rule.'

(38)

a.



b.



In (38a), there are only 2 *ø*'s, while in (38b) there are 3. This comes as a result of the different

functions of the words *vecchia* and *legge* in the two sentences. In (38a), *legge*, the noun 'law' is the head of the phrase and incorporates what is to its left, including, in this case, *vecchia*, the adjective 'old', into a *ø*. In (38b), on the other hand, the verb *legge* '(she) reads', as head of the VP, forms a *ø* by itself. *Vecchia*, here the noun 'old lady', is the head of the NP and thus forms a *ø* along with its preceding determiner.

Our analysis thus shows that syntactic structure plays a role in the perception of sentences, however this role is only indirect. According to a theory of perception in which each level of linguistic representation in the native speaker's competence corresponds to a level of representation computed by the processor, there must obviously be a level of processing corresponding to the syntactic structure. Our proposal does not imply that the syntactic level is no longer relevant, but rather that the syntactic units do not themselves form the initial units of processing. Instead, the syntactic units allow us to construct the prosodic units which then serve as the perceptual units at the initial level of processing. It is for this reason that syntactic distinctions that are not reflected in the prosodic structure are not perceived at this initial level.

6. Conclusions

In this paper, we have provided an analysis of the domains of application of rules of external sandhi in Italian. These domains cannot be adequately defined in terms of syntactic categories. The first of these, the phonological phrase, extends over the left side of a phrase and not the right side. This asymmetry had already been observed by Napoli and Nespor (1979), Rotenberg (1978) and Clements (1978), who argue that in Italian, French, Hebrew and Ewe certain phonological rules must make references to either left or right branches of a syntactic tree. The second prosodic category, the intonational phrase, in addition to not necessarily being isomorphic to any syntactic category, also exhibits a certain amount of variability based on such non syntactic factors as length and rate of speech.

Starting from the observations that syntactic phrases in X-bar type languages are themselves asymmetric in that one side is recursive and the other is not, we have built prosodic categories on the basis of two external sandhi rules in Italian. We have shown that these prosodic categories are the domain of application of other sandhi rules in Italian, French, Spanish, British and American English.

The prosodic categories above the word level, as constructed in this paper, have interesting theoretical consequences in that they can be built only after a syntactic parameter of core grammar has been determined. Therefore, although prosodic structures differ in left and right branching languages, this choice is not made in the phonology independently of the syntax.

Finally, we have shown, on the basis of Italian data, that prosodic categories are used in perception at the first level of processing, in that speakers cannot disambiguate sentences with identical prosodic structures independently of whether their syntactic structures are identical or different.

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