

Gradient prosodic correlates of phrasing in French

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0. Introduction¹

In its modest scale, the present paper advances theoretical claims about the prosodic structure of French, and, at the same time, shows how far these claims are corroborated by empirical results. Crucially, the experiments presented below show that prosodic structure is sensitive to several factors and is subject to variation, and that, ultimately, the grammar of prosody is to be conceived in a way that takes variation into account.

French uses a combination of segmental and tonal cues to signal prosodic phrases, and differs in this respect from a language like English, which relies almost exclusively on tonal boundaries (Pierrehumbert 1980, Gussenhoven 1984). This paper studies the segmental aspects of phrasing and largely ignores the tonal ones (see e.g. Di Cristo 1998, Di Cristo & Hirst 1996, Féry 2001, Fougeron & Jun 1998, Jun & Fougeron 1998, Mertens 1993 and Rossi 1980 for a review of the tonal correlates of phrasing in French). It reports the results of an experimental study of three segmental correlates of phrasing: obstruent voicing assimilation (OVA), nasal-obstruent simplification (NOS) and liaison. It is shown first that these processes regularly take place inside a prosodic domain of the size of a phonological phrase (PhP or simply P), but two of them - obstruent voicing assimilation and nasal-obstruent simplification - are blocked across PhP boundaries, at least when this boundary originates from the presence of narrow focus (see below).

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Their application vs. blocking is not categorical, but applies gradiently, to a greater or lesser degree. The third process, liaison, applies nearly as often across PhP boundaries as inside PhP and is thus to be analyzed as an IP-bounded (Intonation Phrase-bounded) process.

The second result is that narrow focus on a constituent affects the phrasing in the following way. Narrow focus often blocks the application of the first two segmental processes just mentioned, but not of liaison. The interpretation of this effect is that a focused constituent introduces a PhP boundary at its left edge, and a new PhP is formed. Here too, the results indicate that this is not an obligatory process, but rather a gradient one.

Traditionally, generative grammar has been based on categorical claims and a number of models and rules have been advanced which have only sporadically been backed up by experimental material. In this respect, the study of segmental correlates of prosody is no exception. In the recent past, however, the view that the objects of phonology are gradient and variable has begun to be considered seriously. According to “stochastic phonology”, there is no need to eliminate variability, because it provides valuable information and can eventually model the grammar (see Bybee 2000, Frisch 2000, Goldinger 2000, Kirchner 2002 etc). This conception of phonology comes from the belief that cognitive representations are probabilistic. The language learner does not abstract away a purely categorical model, but develops a cognitive system in which frequency information plays a central role. However, as Pierrehumbert (2001) claims, the cognitive system is still grammatical since it establishes the wellformedness of complex forms and has the power to create completely novel forms, as well as to process them. The grammar is probabilistic in the sense that it maintains frequency distributions.

In Optimality Theory, Boersma (1997) and Boersma & Hayes (2001) have shown that constraints do not need to be categorically ranked, but a certain amount of overlapping, to be determined experimentally, can be present in the grammar. Variation in the outputs comes from the different rankings produced by the probabilistic grammar.

The first section of this paper introduces how prosodic phrasing can be understood as a mapping to syntax and information structure, and thus shows how prosodic phrasing is influenced by non-phonological factors. The phonological correlates of phrasing discussed in this paper are the subject of section 2. Section 3 introduces the experimental design and

section 4 shows the results of the experimental study on phrasing and focus. Section 5 presents the main lines of a probabilistic model of grammar and section 6 sums up the conclusions.

1. Theoretical Assumption on Phrasing

Speech is prosodically structured in phrases which correspond to syntactic constituents or to chunks of information structure. In a wide focused (presentational, all-new) sentence, phonological and intonation phrases are primarily determined by the syntactic structure. In such sentences, no constituent is particularly prominent as compared to the other ones. However, sentences in which a constituent is attributed a narrow focus behave differently. In such sentences, the influence of syntax on phrasing can be obscured by considerations of information structure. The distinction between wide-focused and narrow-focused sentences is a crucial one, as observed e.g. by Kiss (1998), who contrasts sentences with a presentational focus (wide focus) and sentences with an identificational focus (narrow focus), and shows that many languages have completely different strategies for the two types of foci.

The syntactic influence on phrasing is universally felt, since all languages organize their utterances in prosodic domains, but crosslinguistically, information structure, like focus or topic, can be encoded by means other than phrasing, usually by phonological, syntactic and morphological ones. Languages may use several of these in different combinations (see Drubig 2002 and Hyman 1999 for typological surveys about the expression of focus). It is well known that English, German and other Germanic languages use accentuation to a large extent, and that sentence accents standing for wide focus are often ambiguous between several focus structures (see Chomsky 1971, Selkirk 1995, Vallduví & Engdahl 1996 and many others). In such languages, the position of pitch accents is determined by rules (see for instance Gussenhoven 1992 for their formulation). In other words, the accent structure, as well as the phrasing, remains stable under manipulation of the focus structure, as long as an answer to a wh-question is congruent with the question. The sentence (1d) can be an answer to all three questions in (1a-c). In each case, the focus, indicated by the different brackets in (1d), corresponds to the wh-phrase. An

answer in which *movie star* is accented and *trees* is not, like in (1e), is not a possible answer to any of the questions in (1a-c).

- (1) Variable focus domain in English
 - a. What does the movie star hate?
 - b. What does the movie star feel?
 - c. What did she say?
 - d. [_F The movie star [_F hates [_F TREES]]
 - e. The MOVIE STAR hates trees.

In French, the primary correlate of information structure is not accentuation, but rather prosodic phrasing. A focused constituent often forms a phonological phrase, which can be accompanied by a syntactic operation such as clefting, topicalization or extraposition of the deaccented material, but is not obligatorily so (see Clech-Darbon, Rebuschi & Rialland 1999). If the syntax allows such an operation on the focused material, then it usually takes place. If not, then focus in situ arises, and, as a result, the focus is tonally, but not syntactically delimited. In other words, the choice between the two techniques - formation of a prosodic phrase corresponding to a syntactic phrase and stress in situ - partly relates to the syntactic potentialities.

Because of the particular importance of phrasing in French, it is necessary to understand how PhPs are mapped to the syntax and how they are identified segmentally and tonally. The tonal structure of PhPs in French has been studied elsewhere and in this paper, only the segmental cues are examined.

Two algorithms have been proposed in the literature for the formation of Phonological Phrases on the basis of the syntactic structure. The first one is the relation-based model, originally coming from Chomsky & Halle (1968), but which has received a formal treatment by Nespor & Vogel (1986) among others. In this approach, PhPs are formed around a syntactic head and include all non-head material up to another lexical head. This process happens to the right or to the left of the syntactic head, depending on which side is syntactically recursive in the language considered. In principle, this method has the effect that prosodic phrases correspond in a one-to-one manner to syntactic phrases. The definition for PhP proposed by Nespor & Vogel is reproduced in (2). The Clitic Group is the prosodic category immediately below the PhP in the prosodic hierarchy.

(2) Default Phonological Phrase Formation (Nespor & Vogel 1986:168)

The domain of PhP formation consists of a Clitic Group which contains a lexical head and all Clitic Groups on its recursive side up to the Clitic Group that contains another head outside of the maximal projection of X.

The other method has been first proposed by Chen (1987) and Selkirk (1986) and maps edges of syntactic phrases with edges of prosodic phrases. This method allows the formation of prosodic constituents which do not match perfectly the syntactic structure since, for instance, a preposition can be in a different PhP than its governed noun, in case the assigned boundary is at the left edge of a DP. Functional heads do not project prosodic phrases.

(3) Edge approach (Selkirk 1986:389)

End parameter setting: x_{\max} [or $]_{x_{\max}}$. The left/right edge of a Phonological Phrase is located at the left/right edge of a Maximal Projection.

In a surface-oriented approach, like Optimality Theory, both approaches are expressible by means of constraints. The edge-based approach is translated into a family of Align-constraints (McCarthy & Prince 1993), which require that boundaries of syntactic phrases fall together with boundaries of prosodic phrases. The relation-based algorithm is most faithfully accounted for by the WRAP constraint (Truckenbrodt 1999) which requires that entire syntactic phrases are mapped into PhPs. The main advantage of OT over the older approaches is that it allows to combine the two kinds of constraints, and predicts typological differences between languages according to the way they rank the relevant constraints (see Samek-Lodovici to appear and Szendrői 2002, among others, for proposals in different languages).

Consider the following utterance in French, its syntactic and prosodic phrasing:

- (4) a. [_{DP} Les petites hirondelles] [_{VP} [ont entrepris [_{DP} leur migration]] [_{PP} à la fin de l'été]
b. (_P Les petites hirondelles) (_P ont entrepris leur migration) (_P à la fin de l'été)

c. (_P Les petites hirondelles) (_P ont entrepris) (_P leur migration) (_P à la fin de l'été)

'The little swallows have undertaken their migration at the end of the summer.'

Prosodic phrasing is taking place according to the syntactic structure. The first DP contains a prenominal adjective, which is always included in the same PhP as its nominal head (see Féry 2004 for an OT account of liaison in this context). Verb plus object also form a PhP together, but only as long as the material is not too long and heavy, and the auxiliary and participle are not separated by an adverb or a negation (*n'ont jamais entrepris* 'have never undertaken' would form one phrase to the exclusion of the following object). In the example in (4), verb and object can be integrated into one PhP, or, alternatively, they are in separate PhPs, depending on the speech style. The last PP is also forming one PhP, as do adjuncts generally.

In a sentence containing a contrastively focused constituent, say when *l'été* is focused, as shown in (5), a PhP is formed on this constituent.

(5) (_P Les petites hirondelles) (_P ont entrepris leur migration) (_P à la fin de) (_{F/P} L'ÉTÉ)]

In other words, some variations arise in the prosodic phrasing in French, but the variations take place inside of well-defined limits, which are themselves of a prosodic or of an information structural nature.

An OT analysis of phrasing is better able to account for the different elements playing a role in the formation of phrases than more rigid rules, like those formulated in (2) and (3). The example in (4) requires that left boundaries of syntactic phrases coincide with left boundaries of PhPs, and (5) that the left edge of a focused constituent coincide with the left edge of PhP. But a restricted amount of recursivity or embedded phrasing must be allowed in order to account for the variation of phrasing in the constellation verb + object. Prosodic constraints acting on the weight of constituents are necessary as well.

The expressions tested in the experiments reported in this paper were all included in a single PhP in their default realization (without narrow focus). They consist of determiner + noun, adjective + noun, numeral plus noun, two numerals, noun + adjective, noun + *de* 'of' complement (mostly lexicalized), compounds (two nouns), preposition + noun,

auxiliary + participle, all of them forming a very tight syntactic and prosodic structure. Some of the expressions used in the experiments are listed in the appendix.

If the hypothesis advanced in this paper that a narrow focus induces a boundary phrase at its left edge is true, the segmental effects found inside of a PhP should be blocked across a focus domain boundary.

2. Segmental correlates of phrasing

Besides tonal correlates of phrasing, French also uses segmental cues (see Delais-Roussarie 1995, Rialland 1994). French is an example of a language with only very few segmental processes applying maximally at the level of the word. Instead, the PhP is used as the domain of segmental alternations. These alternations, called domain-span processes,² obliterate word boundaries inside of PhPs. Three such segmental alternations were the objects of investigation in the experiment described below: obstruent voicing assimilation (OVA), nasal-obstruent simplification (NOS) and liaison.

In OVA, an obstruent in the coda of a syllable assimilates in voicing to the obstruent in the onset of the following syllable. This process takes place inside words (as in *anecdote* /kd/ → [gd] ‘anecdote’ or *abstrait* /bs/ → [ps] ‘abstract’), as well as across word boundaries as long as the words involved are included in the same PhP. An expression like *rêve[v] terrifiant* ‘terrifying dream’ is pronounced *rê[f] terrifiant* because [t] in *terrifiant* is voiceless and causes devoicing of the preceding voiced fricative [v] of *rêve*. Some examples are listed in (6) and some more in the appendix.

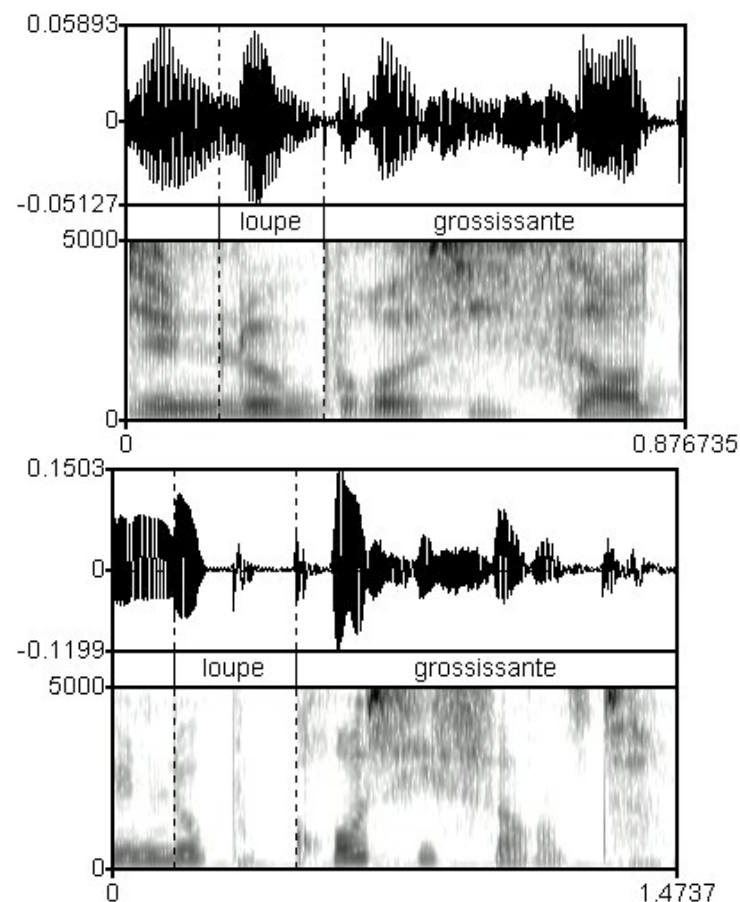
(6) Obstruent Voicing Assimilation (OVA)

bec de gaz ‘gas tap’	/kd/ → [gd]
loupe grossissante ‘magnifying glass’	/pg/ → [bg]
onze francs ‘eleven francs’	/zf/ → [sf]

Figures 1 and 2 show sound waves and spectrograms of *loupe grossissante*, the first one illustrating the application of OVA, and the

² As opposed to edge-span processes which take place at the edges of prosodic phrases.

second showing the same words when OVA has not applied.³ In the first case, the two words are fused together, whereas in the second, there is a break between the two words. There is a clear region of voicelessness around the [p] of *loupe*.



Figs 1 and 2: *loupe grossissante* with and without application of OVA.

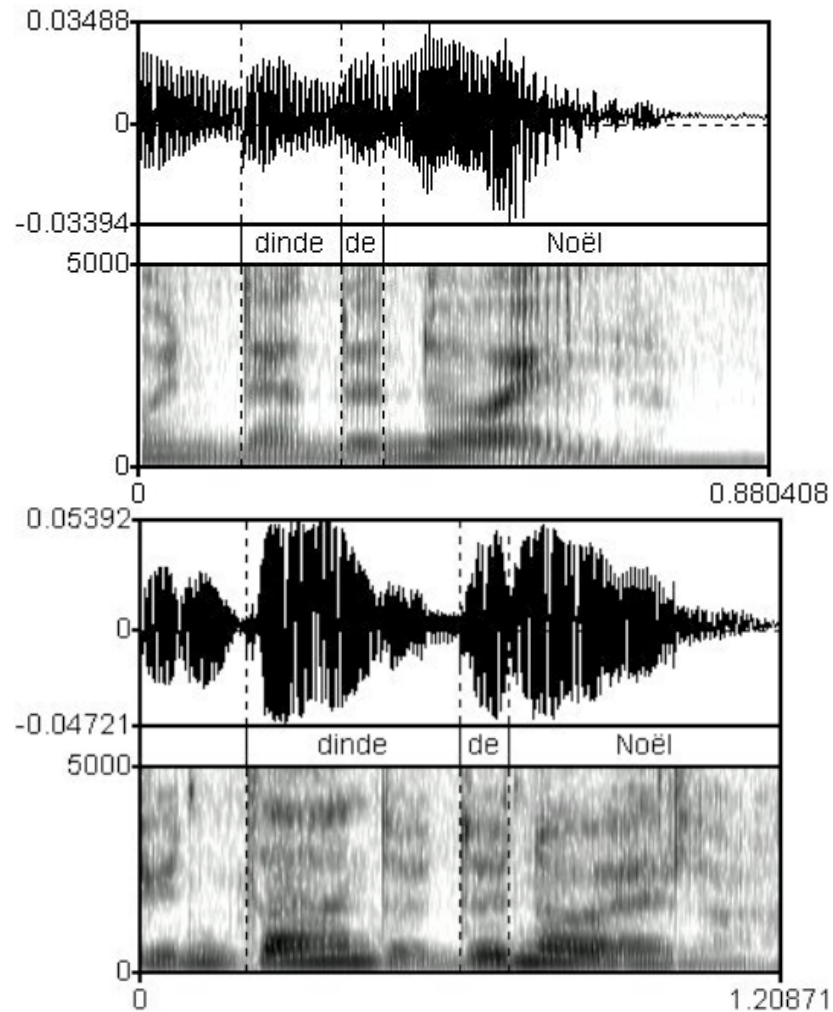
³ The sound files can be downloaded at the URL: <http://www.ling.uni-potsdam.de/~fery/french>

Nasal-obstruent simplification is the process by which a sequence of nasal vowel-obstruent-consonant is simplified into the sequence nasal vowel-nasal consonant-consonant. The medial obstruent is changed into the nasal consonant corresponding in place of articulation. For example, the sequence [ãgm] in an expression like *langue maternelle* ‘mother tongue’ is pronounced [ãŋm] (see also Dell 1986 for this phenomenon). It is to be noted that the syllable structure plays a crucial role. The relevant obstruent has to be in the coda of the syllable of which the nasal vowel is the nucleus. If it can be resyllabified as the onset of the next syllable, as in *bombe atomique* ‘atom bomb’ [bõ.ba.tõ.mik] or *bombe lourde* ‘heavy bomb’ [bõb.lurd] or [bõ.blurd], it remains an obstruent. The consonant following the obstruent to be changed into a nasal is also not indifferent. Obstruents facilitate this process, but, because of the syllable structure just mentioned, sonorants are more resistant, though nasals less so than liquids (see Sabatier 1999). In (7), some the expressions used in the experiment are listed, some others are listed in the appendix.

(7) Nasal-Obstruent Simplification (NOS)

vingt-deux ‘twenty-two’	/ẽtd/ → [ẽnd]
dinde de Noël ‘Christmas turkey’	/ẽdd/ → [ẽnd]
langue maternelle ‘mother tongue’	/ãgm/ → [ãŋm]

Figs 3 and 4 illustrate the effect of NOS. In the first case, where NOS has applied, there is no second stop [d] in *dinde*. The nasalization emanating from the final vowel of this word lasts until the onset of the [d] of *de*. In the second realization, where NOS has not applied, the nasal air flow stops just before this stop, which is itself not nasalized.



Figs. 3 and 4 *dinde de Noël* with and without application of NOS.

In liaison, the third process investigated in this paper, an otherwise word-final mute consonant is realized when the following word begins with a vowel, like in *deux éléphants* ‘two elephants’ [dø.ze.le.fã], where the emergence of the latent coronal fricative [z] of *deux* is triggered by the following word-initial vowel. Enchaînement is the resyllabification

accompanying liaison. As a result, the liaison consonant is the onset of the second word's first syllable (Encrevé 1986, Tranel 1995, Féry 2004).

(8) Liaison and enchaînement

leurs amis 'their friends'	/lœr(z).a/ → [.za.]
petit arbre 'little tree'	/ti(t).a/ → [.ta.]
en Amérique 'in America'	/ã(n).a/ → [.na.]

The next section describes the experiments conducted in order to identify the context of these processes.

3. Experimental design

The aim of the experiment was twofold. First, to test the domain of application of the three segmental alternations described in the preceding section. The hypothesis was that they would be domain-span processes bound by the PhP. Second, to test the effect of focus on these alternations. If a narrow focus has the tendency to form a PhP, these segmental effects should be blocked before a narrowly focused word, even if the morphosyntactic structure predicts no phrase break in this context. These predictions are summed up in (9).

(9) Predictions

- a. OVA, NOS and Liaison are phonological phrase domain-span processes.
- b. The presence of a narrow focus on the second word triggers a PhP boundary and thus blocks these segmental alternations.

The experiment consisted of two series of thirty sentences, read aloud by six native speakers (graduate students, staff or visitors of the Laboratoire de Phonétique of the CNRS in Paris) divided into two groups of three speakers each. The sentences were read as answers to appropriate questions. The speakers had to read each answer (the questions being asked by me) either in a wide focus context or in a narrow focus context, but not in both. The sessions were repeated twice and both trials counted, so that a total of 360 sentences (6 speakers x 30 sentences x 2 sessions) were recorded and analyzed. However, since the relevant expressions were present twice in each wide focus context,

Nouveaux départs en phonologie

there were twice as many wide focus expressions as narrow focus ones. Some examples of the contexts are given in (10) to (12). The first context (a) illustrates the wide focus environment, and the second (b) the narrow focus one. The underlined portion shows the part of the discourse in which the segmental alternation is expected to occur, and the separation line shows the context in which the process is expected to be blocked because of the focus structure.

(10) Obstruent voicing assimilation (OVA)

a. Wide focus environment

Lorsque mes parents étaient jeunes, on éclairait les rues avec des becs de gaz. L'allumeur de réverbères passait tous les soirs et allumait les becs de gaz les uns après les autres.

'When my parents were young, the streets were still lit with gas. The lamplighter came every night and lit the street lights one after the other.'

b. Narrow focus environment

A: Tu parles d'un bec d'oiseau? 'You are talking of a bird's beak?'

B: Je parle d'un bec | de gaz. 'I am talking of a gas tap.'

(11) Nasal-obstruent simplification (NOS)

a. Wide focus environment

Il va de soi que la langue maternelle n'est pas forcément la langue parlée par la mère. Si un enfant est élevé par d'autres personnes qui parlent une autre langue que sa mère, la langue maternelle de l'enfant sera celle de son entourage.

'It is evident that the mother tongue is not necessarily the language spoken by the mother. If a child is raised by people who speak another language than her mother, the child's mother tongue will be that of her surroundings.'

b. Narrow focus environment

A: Comment appelle-t-on la langue qu'on parle le mieux?

'What do you call the language that you speak best?'

B: La langue | maternelle 'The mother tongue.'

(12) Liaison

a. Wide focus environment

Deux éléphants sont nés dans le zoo de Berlin cette année. C'est exceptionnel. Qu'il y ait un éléphant qui naisse dans un zoo, c'est normal! Mais deux éléphants d'un coup, c'est pas banal.

‘Two elephants were born in the Berlin zoo this year. That is exceptional. An elephant born in a zoo is normal! But two elephants at once, that’s too much.’

b. Narrow focus environment

A: Tu as vu ces deux rhinocéros? ‘Did you see these two rhinos?’

B: Ce sont deux | éléphants. ‘These are two elephants.’

To sum up, the hypothesis is that the three segmental processes studied here apply in a nonfocusing environment, but not in a focusing one. If a focus induces the formation of a separate phrase, the boundaries of this phrase should be clearly marked, and the segmental processes applying inside a PhP should be blocked.

4. Results

As already mentioned in the introduction of this paper, the results of the experiments showed that the three processes examined here are gradient rather than categorical. The predictions formulated in (9) and repeated informally at the end of the preceding section were largely confirmed, as illustrated in (13), but not in an absolute fashion.

First, OVA and NOS were found to apply inside of phonological phrases in 80% and 86% of the cases, respectively, when the context called for a wide focus, and in this context, liaison applied even more often (95%). This clear result confirms the first hypothesis and it can be safely claimed that the three processes are domain-span processes applying at least in the domain of a PhP. One can only speculate why the speakers do not apply these processes in a perfectly consistent way, and the hypothesis advanced here, is that none of them is obligatory. In other words, even if the words entering the expressions do form a PhP together, it is not mandatory that all processes signaling a PhP are always realized.

The phonetic realization of PhPs is rendered by a number of tonal and segmental cues, like those studied in this paper. In her paper on extrasyllabic consonants in word initial and word final position, Rialland (1994) mentions further domain-span segmental processes, like liquid drop (as in *arbre* [arb] ‘tree’) and the formation of geminates in connection with schwa drop (*ce soir* [sswar] ‘this evening’). In the experiments reported here, there were also a series of edge-span segmental alternations that were sporadically produced. First, glottal

stop insertion before the focused word as in *petit arbre* [petit ʔarbr] ‘little tree’, where liaison without enchaînement also took place. A second process was lengthening of the onset consonant of the focused word, as in *onze francs* [õz.f.rã] ‘eleven francs’. The third segmental alternation was insertion of schwa before a focused word, as in *dinde de Noël* [dẽdãdãnoẽl] ‘Christmas turkey’, see Fig.4..

Tonal cues of PhP have been studied elsewhere in the literature, and there is no need (and no place) to repeat them here (see above for references). In sum, there are a number of phonological processes and phonetic cues to PhPs, some of which are more important than others. In order to signal a PhP parse, a certain number of these cues must be present, but not all at once. The more there are, the clearer the parsing is. It can be stipulated that tonal cues are more salient and segmental cues less so, though empirical study is necessary before a strong claim can be made.

In the context of narrow focus, the number of realized OVA and NOS processes decreased considerably (36% and 50%). Liaison was not affected, or considerably less so since it still applied in 87% of the cases. These results are summed up in the table (13).

(13) Results

	Wide focus context		Narrow focus context	
OVA	97 of 120	(80%)	22 of 60	(36%)
NOS	103 of 120	(86%)	30 of 60	(50%)
Liaison	114 of 120	(95%)	52 of 60	(87%)

Of the three segmental alternations examined here, OVA provides the result most in line with the prediction. NOS is nearly as good, since it presents a similar distribution: It is less often realized in the context of a narrow focus than in a wide focus sentence.

The results obtained for liaison, however, give rise to a different interpretation. In this case, it is not true that a narrow focus blocks its application, since the difference of realizations in the two contexts does not differ as importantly as before. Only 8% fewer liaisons were obtained in the narrow focus context, as opposed to 43% fewer for OVA and 36% for NOS.

It is to be questioned whether this result is the consequence of a difference in phrasing, or if liaison is just not the right indicator for PhP.

A plausible explanation, which has already been offered above, is that liaison is bounded by a larger domain than the PhP, namely by the intonation phrase (IP). That different segmental processes take place in different domains is also not new,⁴ though, to our knowledge, the claim made here for French has not been advanced before. There is a caveat to be considered, however, before this hypothesis can be taken as granted. Liaison seems to be sensitive to other factors than just the prosodic structure. First, liaison does not apply in some syntactic environments, like between a non-pronominal subject followed by a polysyllabic verb. Second, only a few consonants show up in liaison: [t, s, n, r] are possible liaison consonants, all other consonants are usually not involved in liaison. Third, even when prosodic, syntactic and segmental conditions are fulfilled, liaison seems to be specialized for some items. A word like *très* ‘very’ easily enters a liaison, *assez* ‘enough’, much less often, and adverbs like *vraiment* ‘really’ even less. I refer the readers to the vast literature on liaison (see Encrevé 1986 for an overview). These facts speak against letting liaison play the role of an indicator of phrasing in the same way as the two other process.

5. Model

As has been shown in section 1, prosodic phrases, especially PhPs, are assigned according to the syntactic structure and information structure of the sentences they parse, and the correspondence between syntactic and prosodic phrases can be captured by alignment constraints. This is the categorical part of the grammar. The phonological cues are not categorical, but gradient, as discussed in the preceding section, and the grammatical model should be able to account for this fact.

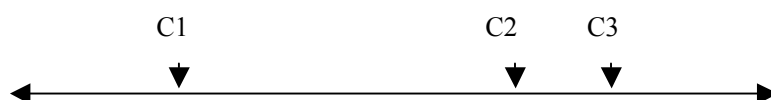
In order to account for gradedness, a stochastic model is most appropriate, like the one proposed by Boersma (1997) and Boersma & Hayes (2001) which is able to integrate noisy data, free variation and gradient well-formedness judgments into the grammar.

Boersma assumes that constraints form a continuous scale of constraint strictness. Constraints are ranked along a continuous scale but they have a certain range. Constraints can be strictly ranked, as shown in (14) and

⁴ See, for instance, Frascarelli (2000), who shows that Raddoppiamento Sintattico in Italian is a PhP-rule, but Gorgia Toscana is Intonation Phrase-bounded.

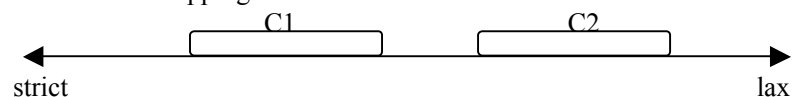
(15a), but they can also have overlapping ranking distributions, as illustrated in (15b).

(14) Categorical ranking along a continuous scale

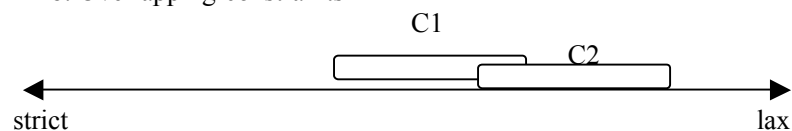


(15) Categorical ranking with ranges (from Boersma & Hayes 2000)

a. Not overlapping constraints



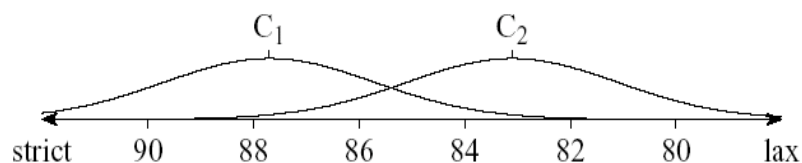
b. Overlapping constraints



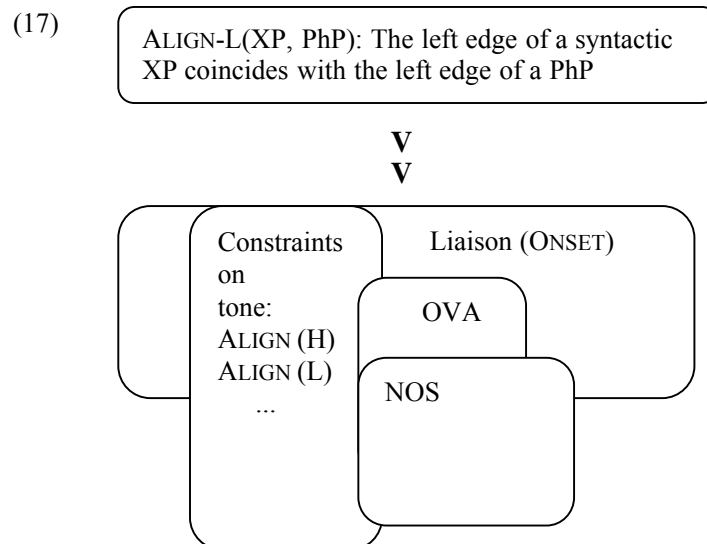
The interesting case for our concern is when constraints overlap, since the constraint which has most of its range before the other dominates most of the time, but there is a region in which the ranking is reversed, and in (16), C2 dominates C1 in something like 5% of the cases.

(16) from Boersma & Hayes (2001)

Overlapping ranking distributions



The variability in the data is accounted for directly in the grammar which actually predicts that a likely process can fail to apply on some occasions. Such a grammar can thus express the tonal and segmental variations observed in correlation with the phrasing of French. The different constraints responsible for the different correlates have a range which partly overlap with each other. Liaison is extremely resistant and applies in spite of a PhP boundary, but OVA and NOS are more sensitive to a PhP boundary. In a particular utterance of a phrase boundary, the hearer can reconstruct the boundary with an increased probability when several cues are present to signal the boundary. A crucial aspect of a gradient grammar is that it can dissociate the presence of a prosodic boundary from its cues. Prosodic phrasing is obligatorily constructed according to a syntactic structure. What is variable is the phonetic realization. In (17), the organization of the different constraints regulating the gradient OT-grammar, as discussed in this paper, is illustrated. The alignment constraints regulating the prosodic parsing on the basis of the syntactic structure are non-gradient and trigger categorical results. The lower-rankin, partially overlapping constraints, abbreviated here with the name of the phonological alternation they trigger, cause gradient results. Liaison is pervasive, tonal effects as well, but OVA and NOS are only present in some cases.



Obviously, a grammar taking other phonological processes into account would be accordingly more complex. In the full model of the correlates of phrasing, each constraint is attributed a ranking value on a continuous scale, the exact values having to be determined empirically. This is a task for the future.

6. Conclusion

It has been shown that besides tonal phenomena, segmental alternations in French are also reliable indicators of prosodic phrasing. Since two of the three alternations studied in this paper are less frequent in the context of a narrow focus, the hypothesis has been confirmed that narrow focus may induce a change in the phrasing by introducing a PhP boundary just before the narrowly focused word. The third process, liaison, was not sensitive to the presence of a narrow focus in the same way, and, as a consequence, it can be assumed that it is a process bounded by IP boundaries. An important result of the experimental research reported in the preceding pages is that the alternations are not realized in a categorical way - always or never - but that they are gradient: they are more frequent in a wide focus context than at the boundary of a narrow focus.

As long as generative grammar was based on rules leading to categorial structures, variation has been largely ignored in the linguistic literature. In the last years, because of the emergence of surface oriented grammars, the introduction of statistical methods, and better tools to measure variation and collect data, theoretical hypotheses can be easily verified empirically. It is to be expected that the results of large-scaled experimental work will ultimately lead us to revise some of the older conceptions of grammar. This paper shows that stochastic grammars can be used in phonology, and that a grammatical model like the Gradual Learning Algorithm of Boersma and Boersma & Hayes can be used for the graded data introduced in this paper.

Appendix: Some examples of contexts

In the example, the longer text was used for wide focus, and the short dialogue was used to induced narrow focus.

A. Obstruent voicing assimilation

1. patte droite

Mon chien est bien dressé, non seulement il donne la patte, mais il donne toujours la patte droite. La plupart des chiens donnent n'importe quel patte. Il n'y a que les chiens vraiment bien élevés qui ne donnent que la patte droite.

A: Ton chien donne la patte gauche?

B: Non, c'est la patte droite qu'il donne.

2. loupe grossissante

Les diamantaires utilisent une loupe grossissante pour vérifier la pureté d'un diamant. Ce n'est pas une loupe grossissante ordinaire, mais une sorte de monocle qui a l'air de tenir d'elle-même sur l'oeil.

A: A quoi sert cette loupe?

B: C'est une loupe grossissante.

B. Nasal obstruent simplification

1. dinde de Noël

C'est bientôt Noël. Jean va aller passer quelques jours chez ses parents. Il se demande ce qu'il vont manger pour le réveillon. Mais il sait que chaque année sa mère prépare une dinde de Noël. Donc, cette année aussi, il est probable qu'ils auront une dinde de Noël.

A: Tu as dit que tu voulais manger une dinde de Pâques?

B: Non, j'ai parlé d'une dinde de Noël.

2. jambe de bois

Dans mon enfance, qui s'est passé vingt ou trente ans après la guerre, on voyait beaucoup de gens avec des béquilles ou une jambe de bois. De nos jours, les prothèses sophistiquées ont remplacé les jambes de bois.

A: Qu'est-ce qu'il a, cet homme? A-t-il une jambe en caoutchouc?

B: Non, il a une jambe de bois.

C. Liaison

1. leurs amis

Cette semaine, c'était la rentrée des classes. Les enfants sont retournés à l'école comme s'il n'y avait pas eu d'interruption. Ils étaient contents de revoir leurs amis.

A: Ils sont contents de revoir leurs professeurs?

B: Non, c'est leurs amis qu'ils veulent revoir.

2. en Amérique

Tous les ans, la famille de Valérie va passer un mois en Amérique. Ils ont de la famille là-bas et les enfants peuvent jouer avec leurs cousins. Pour eux, aller en Amérique, c'est un peu comme rentrer chez soi.

A: Tu vas en Afrique cette année?

B: Non, cette fois, je vais en Amérique.

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