Tonal and Phrasal Structures in French Intonation
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Contents

Chapter 1: Introduction

1.1. Background
   1.1.1. The production and perception of intonation
   1.1.2. The phonetics and phonology of intonation
   1.1.3. The association between intonation contours and text
      1.1.3.1. The relevance of accentual patterns to intonation contours
      1.1.3.2. Factors that play a role in the distribution of pitch accents

1.2. The research questions
1.3. Methodology
   1.3.1. Intonational variation and pragmatic meaning
   1.3.2. Outline of the methodology
1.4. Summary of the findings
1.5. Some issues that are not addressed in this study
1.6. Outline of the thesis

Chapter 2: Theoretical background: modelling

2.1. Earlier descriptions of French intonation
   2.1.1. Coustenoble and Armstrong (1934)
   2.1.2. Delattre (1966b, 1972)
   2.1.4. Concluding remarks
2.2. The Autosegmental-Metrical framework
   2.2.1. Jun and Fougeron
   2.2.2. Di Cristo and Hirst
2.3. Reformulation of the research questions

Chapter 3: Pitch accents, Liaison and the Phonological Phrase: An experimental investigation

3.1. Introduction
   3.1.1. Clash Resolution
   3.1.2. Liaison
      3.1.2.1. The representation of the Liaison consonant
      3.1.2.2. The domain of Liaison
   3.1.3. Summary
3.2. Method
  3.2.1. Materials
  3.2.2. Subjects and procedure
  3.2.3. Analysis
    3.2.3.1. Acoustic analysis
    3.2.3.2. Perceptual analysis
3.3. Results
  3.3.1. Pre-boundary lengthening in Conditions 1 and 2
  3.3.2. The Phonological Phrase boundedness of Liaison and Clash Resolution (Conditions 1 and 2)
  3.3.3. Liaison and Clash Resolution in restructurable Phonological Phrases (Condition 3)
3.4. Conclusion
3.5. Clash Resolution and restructuring
  3.5.1. Hypotheses
  3.5.2. Acoustic analysis
  3.5.3. Results
    3.5.3.1 Phonological phrasing and accentuation in Condition 2
    3.5.3.2 Clash Resolution and fundamental frequency
  3.5.4. Conclusion
3.6. Discussion
3.7. A tentative proposal for the conditions on the application of Liaison
  3.7.1. Syntactic constituency
  3.7.2. Lexical allomorphy
  3.7.3. Precompilation
  3.7.4. Conclusion

Chapter 4: An Optimality-Theoretic account of pitch accent distribution

4.1. Introduction
  4.1.1. Some issues which are problematic for a rule-based account
  4.1.2. Optimality Theory
4.2. The data: ‘default’ accentual patterns
4.3. The ‘default’ dominance hierarchy
  4.3.1. Primacy of the right edge
  4.3.2. Secondary accents
  4.3.3. Summary
4.4. Prosodic variation
  4.4.1. Variation in Phonological Phrase formation
  4.4.2. Variation in the realisation of non-final pitch accents
4.5. Conclusion
Chapter 5: Phonological contrasts and phonetic variation in French pitch movements

5.1. Method
5.1.1. Factors in the choice of elicitation methods
5.1.2. The read speech corpus: Cendrillon
5.1.3. The spontaneous speech corpus: Map Task
5.1.4. Acoustic and auditory analysis
5.1.4.1. Transcription of the corpus data
5.1.4.2. Classification of the pitch patterns
5.2. IP-final pitch movements
5.2.1. Uncontroversial contrasts
5.2.2. Rising movements
5.2.3. Rising-falling movements
5.2.4. Falling movements
5.2.5. Movements with a penultimate peak
5.2.6. Summary
5.3. IP-internal pitch movements
5.3.1. Rising movements
5.3.2. Rising-falling movements
5.3.3. Falling movements
5.3.4. Summary
5.4. Conclusion

Chapter 6: An Autosegmental-Metrical analysis of the intonation contours

6.1. Introduction
6.2. The tonal analysis
6.2.1. Outline of the system
6.2.2. Analysis of the phonologically contrasting pitch movements
6.2.3. Summary
6.2.4. Predictions
6.3. Alternative tonal specifications
6.3.1. Rising and rising-falling movements
6.3.1.1. %LH*
6.3.1.2. L+H*
6.3.1.3. L*+H
6.3.1.4. H*+L H*
6.3.1.5. H+L*
6.3.2. Falling movements and movements with a pre-accentual peak
6.4. Discussion
6.4.1. Jun and Fougeron’s account
6.4.1.1. H* versus H*
Chapter 7: An experimental investigation of final rises 191

7.1. Introduction 191
  7.1.1. Variation within rises 192
    7.1.1.1. Pitch direction 193
    7.1.1.2. Peak height or pitch range 194
    7.1.1.3. Timing 195
    7.1.1.4. Summary 196
  7.2. Experiment I: Categorical Perception. 197
    7.2.1. Method 199
      7.2.1.1. Materials 200
      7.2.1.2. Resynthesis 201
      7.2.1.3. Procedure 205
      7.2.1.4. Subjects 207
      7.2.1.5. Predictions 207
    7.2.2. Results 207
      7.2.2.1. Identification 207
      7.2.2.2. Discrimination 209
      7.2.2.3. Consistency in the judgements 212
    7.2.3. Conclusion 215
  7.3. Experiment II: Contrastive judgements of attitudinal meanings 216
    7.3.1. Method 217
    7.3.2. Results 218
    7.3.3. Conclusion 220
  7.4. Discussion 221

Chapter 8: Summary and conclusion 223

8.1. Introduction 223
8.2. Summary 224
  8.2.1. Introduction 224
  8.2.2. The distribution of pitch accents: The data 224
  8.2.3. The distribution of pitch accents: An OT account 225
8.2.4. Tonal variation: The data 226
8.2.5. Tonal variation: The analysis 227
8.2.6. Tonal variation: Categorical and gradient contrasts and listener 228
judgements
8.3. Scope of the study 229
8.3.1. Phonological theory 229
8.3.2. Methodology 230

References 233

Appendices 247
A: Materials and instructions for the production experiment testing the 247
application of Liaison and Clash Resolution (Chapter 3)
B: Materials and instructions used for the construction of the speech 253
corpora, and details about the prosodic structures produced in the read 261
speech corpus (Chapter 5)
C: Orthographic transcription of the Map Task tapes (Chapter 5) 277
D: Comparison of original F0 traces and retracings 279
E: Excerpts of the score forms used in the Categorical Perception 291
experiment and the semantic task (Chapter 7)

Samenvatting 285

Curriculum vitae 291
On reading the French transcription of E. Paraige [...], one cannot but be struck by the regularity in the incidence of the accent. It seems to fall with insistent monotony on final syllables [...] and one is tempted to ask – does such drab sameness really exist in a living language?

- Stephen Jones in Maître Phonétique 40 (1932), p.74

The “insistent monotony” referred to in the above quotation is probably the most striking characteristic of French prosody for a speaker of a Germanic language. In Germanic languages, the location of the accented syllables in an utterance varies much more than in French. In a neutral reading of the utterance We investigate French intonation, for instance, accents can be realised on the syllables -ve-, French and -na. If the word intonation is replaced with prosody, the antepenultimate instead of the penultimate syllable of the utterance will be accented. This is because the location of the stressed syllable varies between words in English, and speakers have to know for each word whether stress falls on the final, the penultimate or the antepenultimate syllable of the word.1 This is not the case in French, because all words have final stress (‘fixed stress’, Garde 1968).2 Thus, in Nous recherchons l’intonation du français, the syllables -chons, -tion and -cais will be accented in a neutral reading, and if intonation is replaced by prosodie, or any other word for that matter, the accent will still fall on the final syllable of the word. This is probably why Stephen Jones thought that French sounds “drab”.

Nevertheless, accentuation also varies in French. As in English, syllables with secondary stress can be accent. For instance, recherchons can have an additional accent on re-. Secondary stress usually falls on the first syllable of lexical words with more than two syllables (cf. Chapter 4 section 4.2). Whether or not a stressed

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1 In this study, the term ‘stress’ refers to the prominence relations between the syllables of a word in terms of metrical strength. ‘Accent’ is used to indicate the intonational phenomenon whereby some of the stressed syllables show melodic variation (often accompanied by changes in duration and amplitude). In other words, stress determines which syllables can be accented.

2 In words which end in a schwa, the penultimate syllable is stressed (e.g. livre ‘book’, recherche ‘investigate’). However, since word-final schwas are not normally pronounced, the accent can be said to coincide with the final syllable of the word.
syllable is actually accented depends on a number of factors. There is a general consensus that the most important factor in French is word grouping. That is, groups of words that are grammatically and/or semantically related are obligatorily marked by a final accent, and all other accents in the group are optional. However, since different definitions of the word-group are proposed in the literature, there is no agreement about the location of the obligatory accents in the utterance. Moreover, conflicting claims are made about the conditions on the realisation of optional accents. As a consequence, it is unclear which accentual patterns are acceptable in French, and which are not. It is important to know what the patterns are, because they play a crucial role in intonation, the topic of this study.

The term 'intonation' refers to melodic variation in speech. Melodic variation is not random; speakers decide how and when they produce a melodic change. For instance, Anna can be pronounced in various ways in English, as is shown in Figure 1. It matters whether the intonation contour is falling, rising, or rising-falling-rising, because it can change the interpretation of the utterance (e.g. the speaker is making a statement instead of a question, or he is rather surprised or irritated).

![Figure 1: Different intonation contours on Anna and I saw Anna.](image)

Figure 1 also shows that the location of the change can vary, while the type of change is the same. Both realisations of I saw Anna have a rising-falling contour, but the speaker has decided to accent saw instead of Anna in the second case. However, not all differences between intonation contours are important. For instance, if the first rising part of the rising-falling-rising contour on Anna in Figure 1 is omitted, the contour still is essentially the same. Whether a particular difference is categorical or not varies from language to language. Despite the rather large body of literature on French intonation, there is no agreement about which differences between intonation contours are categorical. More specifically, the descriptions disagree about how the direction and the location of the melodic changes can be varied to produce a distinct intonation contour.

This study aims to resolve this controversy by providing a comprehensive description of the tonal structure of French intonation contours and its association with the 'text' (the segmental structure). The stressed syllables and boundaries of the segmental structure determine at which locations melodic changes can occur, and the
tonal structure specifies how the melody can be varied at those points. Thus, the
description makes clear predictions about the nature of the difference between any
intonation contours (i.e. categorical, or gradient within some category), and can be
experimentally verified. In addition, the distribution of pitch accents is described.
That is, the description specifies how the interaction between factors such as word
grouping and the location of the stressed syllables determines at which locations
melodic changes occur (i.e. the accentual pattern).

The following section presents the starting points of the study, and some issues
that are involved in the investigation of French intonation. The research questions
are specified in Section 1.2. Section 1.3 provides a brief discussion of the
methodology. The main findings of the study are summarised in Section 1.4. Section
1.5 presents some issues in French prosody and intonation that are not dealt with
here. Section 1.6 concludes the chapter with an outline of the study.

1.1. Background

In this section, we will refine the definition of intonation given above by briefly
discussing the production and perception of intonation, and the assumption of a
difference between phonetic realisation and phonological categories. Then, the
association between intonation contours and text is discussed to clarify the relevance
of the issue of pitch accent distribution to the description of French intonation
contours.

1.1.1. The production and perception of intonation

An important assumption that is made in this study is that intonation is primarily
concerned with variations in pitch, although changes in pitch are often accompanied
by changes in duration, loudness and voice quality (e.g. Bruce 1977; Beckman 1995;
for French: Martin 1982). Pitch is the perceived rate of vibration of the vocal folds
within the larynx; its acoustic correlate is fundamental frequency. That is, if the
vocal folds vibrate more quickly, fundamental frequency increases, and higher pitch
will be perceived. Pitch is to a large extent independent of the segmental make-up of
the utterance. Thus, two different segments, such as /a/ and /o/, can be produced at
the same pitch, and two different utterances, such as Anna and Anna came, can be
produced with the same pitch movement.

Nevertheless, fundamental frequency values may be affected by the segmental
structure. For instance, voiceless consonants (e.g. /p/, /t/, /t/ and /s/) show up as gaps
in the fundamental frequency trace, as the vocal cords do not vibrate during their

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3 For instance, Martin (1982) claims that the appropriate acoustic features for the description of non-final
intonation patterns in French must be found in the fundamental frequency curves alone, without taking
intensity or duration into account, because the latter do not differ significantly when a different
intonation pattern is used. Amplitude and time only play a role in final falling patterns, which have a
significantly longer duration, lower amplitude, and lower fundamental frequency.
production, and high vowels (e.g. /i/) have intrinsically higher fundamental frequency than low vowels (e.g. /a/), due to differences in the position of the tongue and the larynx. These phenomena are usually referred to as micro-prosodic or micro-melodic effects, and they are not perceptually salient in terms of pitch (for French: Di Cristo 1978 (cited in both of the following); Rossi et al. 1981:39-45; Di Cristo and Hirst 1986). Thus, two fundamental frequency traces that are different to the eye can give the same auditory impression, because the listener automatically neutralises the micro-prosodic differences between them (‘auditory sensation’ Crystal 1969). In this case, the traces are said to be perceptually equal (‘t Hart, Collier and Cohen 1990).

However, it may also be the case that a listener has the same auditory impression of two traces although the differences between them are not neutralised by the auditory system. That is, even when not all of the differences can be attributed to micro-prosodic effects, and some of them can be perceived, they do not affect the listener’s interpretation of the pitch trace (‘auditory interpretation’ Crystal 1969). This means that a description of the intonation contours of a language needs to abstract away from fundamental frequency differences that cannot be perceived, and from differences which can be perceived, but have no effect on the interpretation.

1.1.2. The phonetics and phonology of intonation

The main starting point of this study is that intonation is phonologically structured: intonation contours can be analysed in terms of limited number of discrete, contrasting elements, just like segmentals in speech. In segmental phonology, the inventory of discrete elements of a language contains the vowels and consonants which are capable of differentiating one word from another (e.g. Bloomfield 1935:77-78). For instance, English has the phonemic distinction between /b/ and /p/, as the two can be used contrastively in bin and pin. The difference between the sounds is systemic; the speaker makes a different choice from the phonological inventory (Abercrombie 1991:55-57). Such phonological differences are categorical in nature. Other differences between speech sounds are non-distinctive, and gradient in nature. For instance, the /p/ in pin is usually pronounced with aspiration in English (i.e. [pʰ]), but when it occurs at the end of a word, as in leap, it is not. The difference between [p] and [pʰ] is non-contrastive, because the degree of aspiration cannot differentiate linguistic forms.

We follow Pierrehumbert (1980), Gussenhoven (1884) and others in assuming that there is also a phonology separate from the phonetics in intonation (Di Cristo and Hirst 1996 for French; see Ladd 1996:11-14 and Gussenhoven to appear for discussion). Some variation in fundamental frequency is contrastive, or systematic (O’Connor and Arnold 1968), in which case the difference is to be described in the phonology, and other variation is gradient, in which case it is part of the phonetics. Non-phonological variation in fundamental frequency may arise from a number of factors, such as the segmental structure, the distance between the accents, the location of prosodic boundaries, and topic structure (Steele 1986; Grønnum 1989,
INTRODUCTION

Bruce 1990; Silverman and Pierrehumbert 1990; Van Santen and Hirschberg 1994; Prieto et al. 1995; Rietveld and Gussenhoven 1995; House and Wichmann 1996; Wichmann et al. 1997, Grabe 1998b). For instance, the timing of the peak in an overall rising-falling movement in French has been reported to depend on the segmental structure of the accented syllable and does not affect the interpretation of the pitch movement (Di Cristo 1976; cf. Chapter 5 section 5.2.3). This means that one and the same phonological category (the falling-rising movement here) can be phonetically realised in a number of different ways (the timing of the peak varies). Whether a difference is phonological or phonetic is independent of its 'size'. That is, a small difference in the fundamental frequency trace may change the interpretation of an utterance abruptly, reflecting two different phonological categories, when an apparently much larger phonetic difference can be found to be irrelevant to the listener's interpretation ('t Hart and Cohen 1973).

This view has two important consequences for the way in which we describe French intonation. First, by assuming that intonation is phonologically structured, paralinguistic variation in pitch is excluded from the description. An example of a paralinguistic difference in pitch is given in Figure 2.

![Figure 2: Paralinguistic use of pitch: a greater range conveys greater enthusiasm.](image)

The figure exemplifies that *Il était formidable* 'He was wonderful' sounds more enthusiastic if the speaker increases the range of the pitch excursion (see e.g. Léon 1971 and Fónagy 1983 for intonation and expressiveness in French). This variation is gradient. Although the difference is meaningful, it does not change the linguistic message; that is, both realisations convey a statement. Moreover, the difference can be produced on non-speech sounds such as 'Ehm', in which case it has the same effect of increasing enthusiasm. This indicates that paralinguistic variation is not communicated by means of a formal system, and should therefore not be accounted for in the phonology (Abercrombie 1991:107; cf. Ladd 1996:33-38).

Second, the assumption that intonation is phonologically structured entails that we concentrate on the description of distinct forms rather than functions. A functional approach aims at identifying the characteristics of the functional categories in the language. For instance, falling intonation contours could be said to signal statements, and rising contours questions. However, there is no one-to-one
relation between the forms and the functions of intonation contours. For instance, even though rising contours tend to characterise specific types of questions (e.g. Did you see him?), they can also be realised with a falling contour. In a formal approach, the distinct contours are described regardless of their function. Once the structural differences between contours are analysed, one can proceed to investigate how they relate to pragmatic functions. In other words, our phonological analysis does not aim at developing a theory of intonational meaning.

In sum, our assumptions about intonation entail that categorical and gradient variation in pitch should be distinguished in the description, where the former constitute the phonological forms, and the latter differences in the phonetic realisations of these forms. Although gradient variation can also be meaningful, it should be accounted for in the phonetics. The way in which the phonological categories are defined in a description depends to a large extent on assumptions about the association between contours and text.

1.1.3. The association between intonation contours and text

Descriptions of French intonation make conflicting claims about the phonological structure of the intonation contours. This is partly because the authors have different views about the way in which the contours associate with the segmental structure (see Chapter 2 for a comparison of the frameworks). For some, intonation contours are holistic units that each have their own domain (Rhythmic Groups or Sense Groups, sometimes contained in higher-level Intonation Groups). For others, stressed syllables and/or domain boundaries serve as anchors for the turning points of the contours. This means that the structure is primarily defined by the changes in the direction of pitch, or by the location of these changes. As a consequence, different distinctions between intonation contours are made, but also different predictions about where the distinctions can occur. In our proposal, the intonation contours are analysed as high and low turning points which are localised on stressed syllables and boundaries. The following discussion aims to motivate our choice, and to show why a description of the distribution of pitch accents is included in the study.

1.1.3.1. The relevance of accentual patterns to intonation contours

In French, intonation is primarily used to segment speech; that is, it indicates how words are grouped into word-groups and word-groups into utterances. In Figure 3, for instance, the difference between the pitch movements distinguishes bien (left) as an adjective, which forms a separate word-group with C'est, from bien (right) as an adverb, in which case the following material is included in the same word-group (example from Léon 1992).

Both approaches can describe the difference between the contours. In the holistic approach, the example on the left could, for instance, be analysed as a rise on the first Rhythmic Group, followed by a fall on the second group, and the example on the right as one Rhythmic Group with a rise-fall. In a turning-points approach, the same stressed syllables are accented (i.e. marked by a change in pitch), but the
movements are different because of the difference in boundary weight after *bien*. Thus, both approaches can account for the distinction, because only the difference in grouping needs to be referred to here.

![Figure 3: The intonation contours demarcate groups of words.](image)

However, a holistic analysis cannot account for restrictions on the way in which pitch movements can be combined in a Rhythmic Group when a non-final pitch movement is involved. For instance, *C'est une petite fille* ‘It's a little girl’, which forms one Rhythmic Group, can be realised with a rising-falling movement with a peak on *pe-* , as shown in Figure 4 (a). The utterance can also be realised with an additional pitch peak on *fille*, as in (b).

![Figure 4: Combinatory restrictions on pitch movements (RG stands for Rhythmic Group).](image)

Since the words still form one Rhythmic Group, we would have to assume that this is a different intonation contour, which we will provisionally call a rise-fall-rise-fall.\(^4\)

\(^4\) If both pitch movements occurred on a word-final syllable (e.g. *C'est une fille sympathique* with a peak on *fille* and another on –*tique*), they could be analysed as two separate contours, each belonging to their
The same contours can be realised on *C'est une jeune petite fille* ‘It's a young little girl’, as is shown in Figure 4 (c) and (d). However, examples (e) and (f) show that only the rise-fall is acceptable in *C'est une jeune fille*. That is, the two rising-falling pitch movements cannot occur on immediately adjacent syllables in one and the same Rhythmic Group. This means that the description of the intonation contour needs to specify which syllables can be marked by a change in pitch, and which ones cannot. This problem can easily be solved if the pitch movements are assumed to mark stressed syllables. In that case, we can explain why the contour in (f) is unacceptable: the stressed syllables *jeune* and *fille* are immediately adjacent in the Rhythmic Group, and they cannot both be accented.\(^5\)

Since in the holistic approach, the location of the changes in pitch in the Rhythmic Group is not specified, such restrictions cannot be stated. In the approach adopted here, the ungrammaticality of contours such as (f) can be described, because it can be specified which stressed syllables are accented within the group.

In other words, since some accentual patterns are ungrammatical, the possible forms of the intonation contours are restricted. The question arises whether the conditions can be stated which determine whether an accentual pattern is ungrammatical.

### 1.1.3.2. Factors that play a role in the distribution of pitch accents

A number of factors interact with each other to determine which syllables are accented. First, groups of words rather than individual words are accented in French, as was mentioned above. For instance, in *Arrêtez-le, voleur!* ‘Arrest him, you thief!’ *arrêtez* and *le* are grouped together, and in *Arrêtez le voleur* ‘Arrest the thief!’, *le* groups with *voleur* (the accented syllables are underlined; example from Delattre 1972).\(^6\) The descriptions of French intonation define this group on the basis of semantic criteria, phonological and/or phonetic criteria, or syntactic criteria. The criteria are often reflected in the terms used to refer to the group (e.g. *Groupe de Sens* Coustenoble and Armstrong 1934; Delattre 1966c; *Groupe Rhythmique* Coustenoble and Armstrong 1934; Fouché and Dauzat 1935; Grammont 1966; Delattre 1966b; Ashby 1975; *Breath Group* Pulgram 1965; Vaissière 1992; *Elément Rhythmique* Grammont 1966).\(^7\) The obliteration of word boundaries by phenomena such as Liaison has been claimed to be conditioned by the same domain, i.e. the phenomenon only occurs within the domain, and not across its boundaries (Pulgram

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\(^5\) For the contour in (e) see the analyses of Chapters 5 sections 5.2.4 and 5.2.5 and Chapter 6 section 6.2.

\(^6\) The coincidence of stressed syllables and word-group boundaries has led some authors to deny the existence of word stress in French (e.g. Coustenoble and Armstrong 1934; Pulgram 1965:132-133; see Di Cristo 1999 for a discussion). Nevertheless, metrical prominence appears to be relevant to the assignment of pitch movements, as is argued by Dell (1984) on the basis of the different alignment of intonation contours with utterances that end in a final full syllable and those in which the final syllable was a schwa (cf. Chapter 6).

\(^7\) Some descriptions: ‘... toute unité de mots qui exprime une idée simple et unique constitue un seul élément rythmique et n’a d’accent que sur sa dernière syllabe’ (Grammont 1938:105), “Sense Group is the name given to each of the smallest groups of grammatically related words into which many sentences may be divided” (Coustenoble and Armstrong 1934:3, fn2).
Second, only stressed syllables in lexical words can be accented (e.g. nouns, adjectives, verbs, adverbs); function words (e.g. prepositions, determiners) are only accented when they occur at the end of the group, or when they are contrasted with another word (cf. Chapter 4 sections 4.1 and 4.2).

Third, the location of the stressed syllables relative to each other plays a role. If they are immediately adjacent, they can only both be accented when there is a major prosodic boundary between them (often marked by a pause, cf. Figure 4 (f); Garde 1968; Verluyten 1982; Dell 1984; Hoskins 1994; Mazzola 1994; Delais 1995).

When a non-final and a final accent occur on immediately adjacent syllables in the group, the non-final accent has to be removed (referred to as Clash Resolution).8

Fourth, accentuation depends on speaking style and rate of speech (Coustenoble and Armstrong 1934; Grammont 1966; Delattre 1966b; Wenk and Wioland 1982; Vaissière 1974; 1983; 1992; Pasdeloup 1990a, 1992; Fougeron and Jun 1998). Thus, if a speaker pronounces an utterance very quickly, he will not produce as many accents as in slow and careful speech.

Finally, a speaker can use accents to convey emphasis or to highlight specific elements in an utterance (focus; see Di Cristo 1998 and Di Cristo and Jankowski 1999 for discussion). For instance, C'est fantastique with two accents instead of only one on -stique sounds more emphatic, and in J'ai mangé deux tartines, the speaker stresses that he ate two sandwiches, not one or more (often referred to as contrastive focus). In the latter case, the other words may be deaccented, but this is much more unusual in French than in English (see Cruttenden 1993 for a cross-linguistic study of deaccentuation).9

In sum, five factors have been claimed to influence the distribution of pitch accents in French: word grouping, the grammatical category of the words, the adjacency of stressed syllables, speaking rate and style, and focus and emphasis. Recent descriptions of French intonation have claimed that the domain which is marked by an obligatory final accent corresponds to the Phonological Phrase (Verluyten 1982; Delais 1994). The Phonological Phrase has received a formal definition in the theory of Prosodic Phonology (Selkirk 1984; Nespor and Vogel 1986). The same domain has been claimed to condition the application of Clash Resolution (Verluyten 1982; Hoskins 1994) and Liaison (Verluyten 1982; Nespor and Vogel 1982; Booij 1986; Selkirk 1986; Booij and de Jong 1987; De Jong 1994).

In view of the importance of the domain to the association between the tonal and segmental structures, we decided to investigate whether the formal definition of the Phonological Phrase is empirically adequate.

8 For a possible pattern in which two pitch accents are immediately adjacent in the group see Chapter 6 section 6.2.3.

9 The use of accentuation to convey focus is rather limited in French; instead, the syntactic structure of the sentence is adapted. Thus, 'I think John AND Mary should go there' would be translated as Je crois que Jean devrait y aller, et Marie aussi instead of *Je crois que Jean ET Marie devrait y aller.
1.2. The research questions

The questions addressed in this study can be summarised as follows:
I. When are changes in pitch produced on stressed syllables?
II. Which changes in pitch occur?
III. Which differences are distinct?
IV. How do we present the distinctions in a phonological model?

The first question concerns the interaction between phrasing and accentuation. More precisely, we asked whether evidence can be found for the Phonological Phrase as the domain of the distribution of pitch accents in 'normal' speech (i.e. the utterance has broad focus and is produced at a normal speaking rate in a particular speaking style).

The second question can be narrowed down on the basis of the discussion of the previous section to: which perceived differences in fundamental frequency are produced around stressed syllables and at prosodic boundaries?

The third question asks which variation in pitch is gradient and which is categorical. Once the phonological categories are identified, they can be described in the tonal analysis.

The fourth question asks how the tonal structure can be described such that all and only the categorical differences in pitch movements are accounted for. This means that the description needs to specify how the discrete elements (phonological tones here) can be combined into contrastive contours, and where such combinations occur. The theoretical background of the description will be introduced in Chapter 2.

1.3. Methodology

Distinguishing between phonetics and phonology in intonation is not as straightforward as it may seem at first glance. Not all differences in fundamental frequency can be perceived, and when they are, they are not necessarily meaningful (cf. Section 1.1.1). Also, not all meaningful differences represent categorical distinctions (cf. Section 1.1.2). In this section, we will briefly discuss the problem, and how we attempted to resolve it.

1.3.1. Intonational variation and pragmatic meaning

Variation that is used categorically is difficult to tell apart from truly gradient variation in an intonation contour, because the two interact. For instance, a difference in pitch height can represent a categorical distinction at the beginning of an utterance, as is shown in Figure 5 (Grabe et al. 1997). In the figure, the same pitch accents are chosen (L*HH% in Gussenhoven 1991b), but the preceding unaccented syllables are pronounced at a high level (left; 'high onset') or at a low level (right; 'low onset').
Differences in pitch height can also be non-distinctive. For instance, the average pitch of men is lower than that of women. This type of gradient variation will interact with the categorical variation in the onset of the examples of Figure 5 to produce varying fundamental frequency values. The criterion for deciding when variation is distinctive is the contribution to the pragmatic interpretation (i.e. changing the values of the onset relative to the pitch accent leads to a different interpretation of the contours; an overall higher or lower realisation of the utterance does not).

However, not all differences in meaning are necessarily phonological in nature (e.g. the paralinguistic use of pitch range to signal increasing enthusiasm in Figure 2). Therefore, pragmatic meaning may not be a reliable source of evidence for phonological contrasts. Also, since there is no generally accepted theory of the relation between phonological forms and pragmatic meaning, meaning-based evaluations of competing phonological accounts must be inconclusive (Ladd 1996:101-102).

Yet, the fact that the intonational categories cannot easily be identified does not invalidate the assumption that phonological forms are distinct from phonetic realisation mechanisms. It does mean, though, that conclusive evidence for the phonological distinctions is difficult to collect. The present study attempts to take this limitation into account by adopting the approach known as laboratory phonology, where the empirical analysis of production and perception data forms the basis of the phonological description.

1.3.2. Outline of the methodology

Two carefully constructed corpora of spontaneous and read speech were analysed auditorily and acoustically. First, the pitch movements were inspected, comparing realisations across speakers and contexts, which resulted in a first classification into discretely different contours. The contours were compared with those described in the literature, and the inventory of contrasting contours was drawn up. Then, the contours were formalised in a phonological description (the tonal analysis of the contours). Finally, the original pitch contours were compared with the contours predicted by the phonological description (see Chapter 5 section 5.1 for further details).

To substantiate the analysis, two perception experiments were carried out on
the assumption that what is analysed as similar in the phonological system should be perceived as similar by the listeners (Gussenhoven 1984:267-287; Gussenhoven and Rietveld 1991). Being discrete, phonological differences were predicted to have strong effects, unlike phonetic differences which are gradient in nature, even when they are meaningful. This investigation concentrated on some of the more controversial cases, since not all predictions made by the analysis could be tested (see Chapter 7 for further details).

One further remark about the methodology are in order. The analyses needed to abstract away from sociolinguistic variation due to, for instance, differences between dialects, speakers, speaking styles and context. Therefore, the investigation was limited to speech produced by a fairly homogeneous group of speakers, comparing their realisations in various contexts and speaking styles. All subjects in this study were academically educated, from the north of France (mostly from Paris), and aged between 18 and 30. We assume that their variety of French is a close approximation of ‘General French’, which Di Cristo (1998) defines as a non-regional accent without local characteristics, mostly spoken by educated people as well as professional broadcasters (comparable to RP or General American).

1.4. Summary of the findings

The main findings of the study can be summarised as follows (note that the terminology and details of experimental procedure are discussed in the following chapters):

I. The study provides a coherent phonetic and phonological picture of phrasing and pitch accent distribution. More specifically, the following conclusions are drawn.

- The application of Clash Resolution is conditioned by the Phonological Phrase.
- The application of Liaison is not conditioned by the Phonological Phrase.
- The Phonological Phrase is measurable in the duration of the pre-boundary syllable.
- Pitch accent distribution is conditioned by the Phonological Phrase: phrase-final accents are obligatory, and clashes between immediately adjacent accents are prohibited.
- Restructuring of Phonological Phrases is not restricted to lexical heads and their non-branching complements. Rather, Phonological Phrases are mapped onto the projections of X-bar category heads in the morpho-syntactic structure, where factors such as the number of syllables and speaking rate determine whether the Phonological Phrase spans an X' or an X'' projection.
- A constraint-based analysis accounts for the interaction between phrasing and pitch accent distribution: the grammar predicts which forms surface in cases of prosodic variation, and still excludes categorically ungrammatical output forms.

II. The study provides a comprehensive account of the tonal structure of French
INTRODUCTION

intonation contours and its association with the segmental structure. More in particular, our findings are as follows.

- Seven categories are identified in Intonation Phrase final position: falling movements to mid and to low, falling movements from a penultimate unaccented peak to mid and to low, rising movements to high and to mid, and rising-falling movements.

- Three categories are identified in Intonation Phrase internal position: a rising, a rising-falling and a falling movement.

- A small set of tonal primitives accounts for the categorical distinctions: two pitch accents, five boundary specifications (two initial and three final), and an optional L-tone.

- There is no need to distinguish between an underlying and surface level in the phonology, since the tones of the underlying structure are not phonologically modified or deleted.

- The distinction between the phonological and the phonetic levels of representation makes explicit predictions about discreteness and gradience in variation in pitch, which can be experimentally verified.

- Differences in attitude can be detected in phonetically different contours representing phonologically identical intonations.

III. The analyses are based on a variety of experimental methods. As a result of our experimentation, a number of conclusions could be drawn.

- A production experiment successfully investigated the interaction between Phonological Phrasing, pitch accent distribution and the application of Liaison.

- Clear hypotheses about French intonational contrasts could be drawn up on the basis of an auditory and acoustic analysis of a speech corpus with two speaking styles.

- Categorical Perception paradigm may be unsuitable for the investigation of intonational contrasts.

- The pragmatic contribution of gradient and categorical variation in pitch was successfully investigated by means of contrastive judgements of attitudinal meanings.

1.5. Some issues that are not addressed in this study

A number of issues in French prosody and intonation are not dealt with in this study. First, no proposal about French foot structure is included in this study, because we found that feet need not be referred to in order to account for the association between the tonal and segmental structures (see Chapters 3 and 4). That is, foot structure may well be relevant to other phonological processes in French, but cannot be motivated on the basis of pitch accent assignation.

Second, the influence of focus on the accentual and phrasal structure of utterances is not investigated. We adopt the view that deaccenting and dephrasing
can take place in utterances with early focus, but that this is by no means obligatory (Di Cristo and Jankowski 1999; Jun and Fougeron to appear).

Third, the study does not investigate the difference between emphatic, focal, rhythmic and demarcative pitch accents. These various functions have been claimed to be consistently related to word-initial as opposed to word-final accents, or to differences in the realisation of pitch movements occurring at either of these locations (see Dahan and Bernard 1996; Di Cristo and Hirst 1997 and Di Cristo 1999 for overviews). We take the position that all pitch movements associated with stressed syllables are pitch accents in the phonology (H* or H+H* in the analysis proposed here).\(^\text{10}\) Thus, the functional differences are not part of the phonology, although they may affect phonetic implementation (e.g. strong emphasis is often reflected in a higher accentual peak in Germanic languages, and this could be the case in French as well).

Fourth, the study does not cover the phonetic implementation of the tonal structure. We have not investigated how factors such as the segmental structure, the number and location of surrounding pitch accents, the location of prosodic boundaries, and topic structure affect the timing and fundamental frequency values of tonal targets and the transitions between them. Further research is needed for the description to be directly applicable in, for instance, speech synthesis, language learning and forensic research.

Finally, the aim of the study was to describe the phonological aspects of French intonation, not its semantic or communicative aspects. Although they are closely connected, as was explained above, we consider the identification and formalisation of the patterns that are used consistently in French as our first task. As is the case for the interaction between the phonology of intonation and the other components of the grammar (e.g. syntax, morphology), its relation to semantics falls outside the scope of this study. As a consequence, the study’s contribution to the development of a theory of intonational meaning must be limited.

1.6. Outline of the thesis

The following chapter is introductory. It presents the theoretical background of the study by comparing previous analyses couched in different frameworks with the Autosegmental-Metrical framework adopted here. Chapter 3 reports a production experiment which investigated the interaction between phrasing and accentuation. In Chapter 4, the distribution of pitch accents is accounted for in the framework of Optimality Theory (Prince and Smolensky 1993). The investigation of Chapter 5 aims at identifying the intonation contours that should be captured by the phonological description. Chapter 6 gives our proposal for an Autosegmental-Metrical account of these findings. The predictions of the analysis and alternatives to the phonological specifications are presented, and its advantages over competing

\(^{10}\) The assumption that pitch movements associated with word-initial syllables should be analysed as pitch accents is defended in Chapter 3 section 3.3 and Chapter 6 section 6.4.
autosegmental accounts of French intonation are discussed. Some controversial predictions of the account are experimentally tested in Chapter 7.
Chapter 2  Theoretical background: modelling

The complete list of all melodies that are produced on utterances in a particular language might constitute an observationally adequate description, but would not be a descriptively adequate analysis (Chomsky 1970). That is, it cannot provide a meaningful account of intonation, because it fails to capture generalisations about intonation contours both within the language in question and across languages. As was explained in the previous chapter, intonation is an autonomous system with an internal structure. For an analysis to be descriptively adequate, this structure needs to be defined. In other words, what is the nature of the elements that can be combined in the system, and what are the primitives?

Different approaches to the decomposition of intonation contours into discrete elements have been chosen, ranging from configuration-based analyses to analyses in terms of distinct pitch levels ('global' versus 'atomistic', Bolinger 1951). Examples of the former are the Dutch approach developed at the IPO (Collier and 't Hart 1981; 't Hart et al. 1990), and what is generally referred to as the 'British tradition' (e.g. Halliday 1967; O'Connor and Arnold 1968; Crystal 1969). Here, the intonation contour of an utterance consists of a sequence of discrete pitch movements (e.g. rises and falls). The movements are the primitives of the intonation structure; at the phonological level, the inventory of the movements and the way in which they can be combined is given. Examples of the levels approach are American structuralist descriptions (e.g. Pike 1945; Trager and Smith 1951), who decompose the intonation contour into its component levels, usually four (Low, Mid, High and Extra High, indicated by numbers). The Autosegmental-Metrical approach adopted in this study is an exponent of the levels approach, because it also analyses pitch movements in terms of pitch levels (for a comprehensive overview see Ladd 1996:42-112). The main differences with the levels approach are that it recognises only two levels in the phonology, the minima and maxima of the contour (High and Low tones), and that the way in which they are associated with the text is formally specified. When they are associated with the text, each tone has its phonetic target. These targets are then connected through phonetic transitions to form the surface melodic contour. Thus, the analysis can make reference to the turning points in the contour (the levels), while capturing the fact that only some configurations of tones are distinctive (the pitch accents and boundary tones). The same array of frameworks has been applied to the analysis of French intonation.¹

The French analyses also vary along a second dimension: from functional to

formal. In a functional approach, the aim is to identify intonation contours which characterise functional categories such as statements and questions, whereas in a formal approach, the linguistically relevant differences between intonation contours are defined regardless of the way in which they are used in the language. As was pointed out in the previous chapter, a phonological description primarily aims at identifying the inventory of contrasting forms rather than attributing specific forms to functions, because one form can have various functions, and vice versa.

In this chapter, an Autosegmental-Metrical approach to the analysis of French intonation will be motivated. Three earlier descriptions of French intonation will be discussed in the following section, outlining their basic assumptions and the main arguments that can be raised against them. In section 2.2, the Autosegmental-Metrical framework is presented, and two Autosegmental-Metrical proposals for French are reviewed. The discussion leads to the formulation of the research questions addressed in Chapters 3 and 4, and Chapters 5 and 6, respectively (Section 2.3).

2.1. Earlier descriptions of French intonation

The descriptions discussed below are chosen because they aim to provide a comprehensive account of all contours in French. They serve to illustrate the differences between the various approaches, and thus allow us to clarify the starting-points of our analysis. The first description is configuration-based, analysing intonation in terms of holistic contours. The second is a pitch-levels analysis, in which the distinct pitch movements are defined from a functional perspective. The third description is closer to the Autosegmental-Metrical framework, because it also analyses the contours in terms of High and Low tones.

2.1.1. Coustenoble and Armstrong (1934)

Coustenoble and Armstrong provided the first reasonably comprehensive description of French intonation. It is a more elaborate version of the relevant chapter in Armstrong and Jones (1932), and both were written for teaching purposes, aimed at English students of French. The authors distinguish three global contours in unemphatic speech: (1) rise-falling intonation, (2) falling intonation, and (3) rising intonation, exemplified in Figure 1.

![Figure 1](image_url)

Figure 1: The global intonation contours of French according to Coustenoble and Armstrong (1934).
The highest point in the rise-falling contour is reached on the penultimate syllable. The contour is mainly used in short assertions. In the falling contour, which is typically used in question-word questions and commands, the highest pitch is realised on the first important word in the utterance (e.g. the question-word). The rising contour is used in statements with implication and questions.

The contours are claimed to characterise 'Intonation Groups', which can be 'broken' in longer sentences. The Intonation Groups appear to be defined on the basis of the global characteristics of the intonation contour. An example of a 'broken' Intonation Group is given in Figure 2. The figure shows that in 'broken' Intonation Groups, the direction of the curve suddenly changes upward before returning to the original direction (here falling; Coustenoble and Armstrong 1934:60-61). The sudden changes occur at the end of Sense Groups, which are defined as a "...group of words (sometimes one word only) having in itself a certain sense, not necessarily complete" (Armstrong and Jones 1967:132, also Grammont 1938:105).

![Figure 2: A falling contour in a 'broken' Intonation Group. The dotted line indicates the break realised between the Sense Groups.](image)

The different ideas expressed in the utterance can be given more prominence to by marking each Sense Group in this way, or by dividing the utterance into several Intonation Groups (Coustenoble and Armstrong 1934:75). For instance, in a rise-falling contour, the highest point will occur after the introduction of the main idea, and the falling part gives an impression of completeness about this idea. The location of the highest point varies within and across speakers (Coustenoble and Armstrong 1934:88), as is shown in Figure 3.

![Figure 3: A rise-falling contour on an utterance with three groups. The dotted lines indicate the boundaries between the groups (coincide with Sense Groups).](image)

When the rise-falling and the falling contour are followed by an "expression of small significance" such as *dit-il*, and *monsieur* (often referred to as appendices), its pitch
is low level or slightly falling, and when the contour is rising, the appendix is also rising. Note that the appendix is not presented as a separate contour (cf. Delattre's *echo* and *parenthèse* below).

Clearly, pitch movements are described as holistic units here, predefined chunks of intonation. The description abstracts away from the details in the contours, and their internal structure is left largely unanalysed. Thus, the description does not formalise the relation between the contours of Intonation Groups that are embedded in a larger Intonation Group and the global contour of the utterance as a whole. For instance, the global rise-falling contour of Figure 3 appears to consist of two rises followed by a rise-fall. Would the global contour still be classified as a rise-falling contour if the last Intonation Group was falling or rising? Also, can the rise-fall of the final group be preceded by other rise-falls, or by falls instead of rises? In other words, it is unclear how the contours can be combined in an utterance, and to what extent these choices are distinct.

The description also illustrates a more general drawback of the configuration-based approach, which is that it does not reflect the importance of the location of the turning points in the contour (Ladd 1996:64-66). For instance, a fairly consistent difference in the pitch level of the end-point of rising movements has been reported in French questions and continuations (used to signal that the utterance is not yet complete; cf. Chapter 7 section 7.1.1.2). Such differences cannot be captured in a configuration-based approach, because only changes in pitch can be represented. Also, whether the peak in a globally rising-falling movement is located at the end of a non-final group, on the penultimate syllable of a group, or in the final syllable cannot be expressed, although these differences are significant in French (see Chapter 5 section 5.2 for a discussion). Thus, the description cannot capture the consistency in the pitch levels and the temporal alignment of pitch movements, because the internal structure of the contour is not formalised.

2.1.2. Delattre (1966b, 1972)

The most influential description of French intonation is probably Delattre's. He analyses melodic contours in terms of four distinct pitch levels, identifying ten different intonation contours. The contours are given in Figure 4. Apart from the contours with a fall from level four, which are "not clearly distinctive among themselves", all contours are discrete units (Delattre 1972:171). The units are defined on the basis of the pitch levels at which they start and end, with the exception of the rises to level four, which differ in the changing rate at which they rise (increasing in the *question* and decreasing in the *continuation majeure*, i.e. convex as opposed to concave) or in the end-point (falling in the *implication*).

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2 The aim of the authors was to teach English students how to produce French intonation contours and when to use them, not to provide a phonological description. Nevertheless, the approach leads to some confusion.
Delattre's *dix intonations de base* 'ten basic intonations'.

The categories are distinguished on the basis of their grammatical function, which is reflected in their labels. Figure 5 exemplifies how an utterance is decomposed into three contours (the pitch movements are represented as stylised contours).

**Figure 5:** The functions of the intonation contours: (1) minor continuation contour, (2) major intonation contour, and (3) implication contour.

Minor intonation contours mark non-final Rhythmic Groups, or Sense Groups, which Delattre defines on semantic grounds in the way Coustenoble and Armstrong do. The function of the major continuation contour is to indicate that two Rhythmic Groups are grouped together into a larger unit of meaning (Delattre 1972:169). The third rising-falling contour (*intonation d'implication*) implies that the listener did or...
should have known that Laure is intelligent, and contrasts with the neutral utterance-final fall which conveys finality (*intonation de finalité*).

The implicit assumption of Delattre’s inventory that there is a one-to-one relation between form and grammatical function leads to the specification of too many phonological categories on the one hand, and on the other, it misses some linguistically relevant differences between the contours. For instance, rising movements to level four can be used to signal different grammatical functions, and the description expresses this as a formal difference between convex and concave rises. However, this difference is by no means consistent (discussion in Chapter 5 section 5.2.2). Also, it misses formal distinctions which do not signal differences in grammatical structure, such as the difference between falls to low and falls to the middle of the speaking range, which can both be used in statements (Chapter 5 section 5.2.4). Delattre presumably analyses them as the same category (*intonation de finalité*), since no mention is made of falling movements that do not reach the bottom of the speaking range. Finally, the restrictions on the way in which the contours can be combined are not specified. A correct inference is probably that only the *continuation mineure* and the *continuation majeure* can occur in Rhythmic Groups that are non-final in the utterance, but this restriction does not follow from the description.  

In addition to approaching intonation from a functional perspective, Delattre’s analysis is couched in the pitch-levels approach, which again leads to missed generalisations in some cases, while positing too many phonological categories in others, since the intonational events are not formally related to specific points in the temporal domain. This is a characteristic it shares with Coustenoble and Armstrong’s configuration-based approach. Despite the introduction of distinct pitch levels, the contours are essentially holistic units which are only vaguely associated with Rhythmic Groups. This means that the consistency in the temporal alignment of the contour cannot be expressed. On the one hand, a number of intonation contours cannot be described at the phonological level. In addition to the peak-timing example discussed at the end of the previous subsection, pitch movements that do not occur at the end of a Rhythmic Group (e.g. at the beginning of a word) cannot be analysed in Delattre’s approach. On the other hand, the specification of contours at four pitch levels results in too many distinctions, and thus, some apparent similarities between the contours are not captured in a parsimonious way. For instance, the *continuation mineure* is distinguished from the *continuation majeure* at the phonological level. The only formal difference between them is a difference in the final pitch level. Although this difference is very likely to be systematic in the phonetics, it does not need to be included in the inventory of phonological forms, because it can be explained on the basis of the prosodic structure of the utterance (in terms of phrasing and accentuation), as will be shown in Section 2.2. Moreover, the

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3 Also, since Delattre states that the *continuation mineure* can take the form of a fall (Delattre 1972:169), we have to conclude that contours other than rises to level 3 and 4 are apparently allowed in this position. The stipulation that the *continuation mineure* can be rising or falling also suggests that certain forms have more than one function.
assumption of four distinct pitch levels as primitives in the description predicts a number of configurations that do not exist (cf. Bolinger 1951). The question arises why configurations like ‘1-3’, ‘4-1’, and ‘1-4-’ exist, while ‘3-1’, ‘4-3’ and ‘1-2-’ do not. In other words, the number of levels is arbitrary; Léon has five.


In a more recent treatment of French intonation, Mertens proposes to analyse intonational contours in terms of a sequence of tones (High and Low) that are each linked to a syllable. When they are associated with stressed syllables, the tones are indicated by higher case in the transcription, and are defined at four different pitch levels, H, L, H* and L*, where H* and L* represent the extremes of the speaker’s pitch range. Word-initial and word-final pitch movements are assumed to be phonologically distinct, transcribed as a specification with one as opposed to two tones, as can be seen in Figure 6, and this reflects the difference in duration between word-initial and word-final accents (word-final accented syllables are usually longer). In addition, unaccented syllables are tonally specified, indicated by lower case in the transcription. This analysis results in an inventory of the thirteen different elements given in Figure 6, referred to as ‘morphemes’ by Mertens. However, since many of the tones of the morphemes can also be raised or lowered (e.g. \HH for a word-final accent), we are not sure how many different phonological categories are being defined.\footnote{Since the word-initial accent is rarely L, Mertens does not list this specification in all of his articles. Also, \- is given as a possible specification for unaccented syllables, but Mertens claims that it can only occur in appendices.}

<table>
<thead>
<tr>
<th>Groupe Intonatif:</th>
<th>Unaccented:</th>
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<td></td>
<td>h, l or l-</td>
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<tr>
<th>Word-initial accent:</th>
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<tbody>
<tr>
<td>H or L</td>
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<tr>
<th>Word-final accent:</th>
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</thead>
<tbody>
<tr>
<td>LL, LH, HH, HL, HL-</td>
</tr>
<tr>
<td>H+H+, H+L, or L-L-</td>
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</tbody>
</table>

Figure 6: Mertens’ tonal categories and their distribution in the intonation group. Curly brackets indicate the optional elements in the intonation group, ‘Li’ and ‘Ll’ stand for the initial and final location of the sequence of unaccented syllables.

Every word-final accent marks the end of an Intonation Group. The size of the Intonation Groups (i.e. the location of the word-final accents) is conditioned by the syntactic structure, but their formation also needs to respect certain morphological and phonological constraints (see Mertens 1993a for a discussion). The way in which
the tonal morphemes can be combined depends on a number of factors, such as the identity of the tones (e.g. appendices only occur after certain types of word-final accents), the number of syllables in the Intonation Group and, again, the syntactic structure (Mertens 1993a). For instance, consecutive Intonation Groups can be grouped together, which relation is indicated by the value of the final accent of the second group. That is, the tones are hierarchically organised, where L- dominates H+, both dominate H, and all three dominate L (Mertens 1990:169-171). Thus, in Figure 7, the final accents of the three Intonation Groups reflect the hierarchical relations between them. We have applied Mertens’ analysis to the utterance that illustrated Delattre’s account in the figure (cf. Figure 5).5

![Diagram of intonation groups](image)

**Figure 7:** Example of Mertens’ account. ‘\’ and ‘/’ indicate lowering and raising, respectively.

The tonal specification on *su* dominates that on *Laure*, which in turn is dominated by the configuration on *-gente*.6 The hierarchical relations expressed by the tonal structure have to be congruent with the syntactic structure.

Mertens’ description is observationally adequate, in that it gives a detailed account of the phonetic realisation of the intonation contours, but this degree of phonetic detail is unlikely to reflect the system of phonological contrasts. Figure 7 illustrates that it fails to capture the similarity between the movements on *Laure* and *su*, which are given very different tonal specifications. Thus, like Delattre’s account, it ignores the fact that some characteristics of the intonation contours are predictable, as was argued above.7 Also, the fact that unaccented syllables are specified for tone reduces the predictive value of the model. There is no need to specify the tonal value of every single syllable, because if left unspecified, they can automatically be assigned their correct values in the course of phonetic implementation (Pierrehumbert 1980). The same applies to the tones associated with the word-final

---

5 The transcription is our interpretation; the details may not be entirely correct, as Mertens illustrates his transcriptions by means of a representation of his auditory impression of the intonation contours that is very similar to Coustenoble and Armstrongs’, instead of using contours or F0 traces (e.g. ‘\’l...‘l’ in Figure 7 might in fact be ‘h...‘l’ in Mertens’ view).

6 We are not entirely sure that HL dominates HH in Mertens’ view.

7 As will be shown in the following section, we agree with Mertens and Delattre that the movements should have different tonal representations, but the difference is attributed to a difference in boundary weight, and not to a different specification for the pitch accent, as Mertens does. Thus, the similarity of the movements can be captured, and the analysis is more parsimonious.
syllables, which Mertens defines at four different levels (cf. the objections raised against Delattre’s four levels). In other words, the description does not clearly separate the phonetics and phonology of intonation.

2.1.4. Concluding remarks

The grouping of words - whether defined on semantic (e.g. Coustenoble and Armstrong, Delattre) or syntactic grounds (e.g. Mertens) - is generally assumed to be an important factor in the location and the nature of the intonational events in French. It affects the distribution of pitch movements in an utterance, and the way in which they can be combined. This strongly suggests that a descriptively adequate model of French intonation should formalise the association between the intonation structure and the text. In our view, this can be done more successfully in the Autosegmental-Metrical approach, because the distinction between pitch accents and boundary tones allows the account to be more parsimonious. The discussion also revealed that the absence of a clear distinction between the phonetics and the phonology of intonation obscures the phonological differences between pitch movements in previous analyses.

We aim to show that French intonation can be phonologically analysed by means of two phonological tones, High and Low, which are associated with the text in a principled way. This analysis posits a smaller phonological inventory than did earlier analyses. The analysis claims to predict all and only the intonational contrasts of French, while being explicit about the ways in which the phonological structures are pronounced in different contexts.

2.2. The Autosegmental-Metrical framework

In the Autosegmental-Metrical framework, intonation contours are analysed as linear sequences of locally specified targets which are linked up by means of phonetic transitions (Pierrehumbert 1980; Pierrehumbert and Beckman 1988; and others). The phonetic targets correspond to tones (High or Low) in the phonological representation, and these tones associate with metrically strong syllables (T*) or the boundaries of prosodic units (T%). The inventory of pitch accents and boundary tones may vary from one language to another. The model leaves the stretch of speech between pitch accents and boundaries unspecified for tone. Along with the phonological tones, this stretch receives its surface fundamental frequency value in the course of phonetic implementation, when pitch is interpolated between the targets. The way in which the tonal targets are phonetically realised is defined by a

8 Whenever we use the term ‘(pitch) accent’ in this study, we refer to the set of tones of the intonation contour that associate with metrically strong syllables. The term ‘stress’ refers to themetrical prominence relations that hold between syllables (the metrical structure). Thus, stress is the potential for accent: accented syllables are also stressed, but stressed syllables do not have to be accented (cf. Bolinger 1972:22).
set of language-specific implementation rules.

In Figure 8, the analysis is exemplified for the utterance of Figures 5 and 7 (the details of the analysis will be discussed in Chapter 6). As is shown in the figure, the contour is decomposed into pitch accents and boundary tones. The starred tones associate with the accented syllables *Laure*, *su* and *-gente* (the final schwa is not normally pronounced), and the boundary tones associate with the edges of the two Intonation Phrases of the utterance.

![Figure 8](image)

**Figure 8:** Example of an Autosegmental-Metrical analysis of a French utterance (the phonetic representation in terms of fundamental frequency is represented as a stylised contour).

Relative to the descriptions discussed in the previous section, the analysis has several advantages. First, there is no need to specify the tonal value of every single syllable, because, if left phonetically underspecified, many can automatically be assigned their correct values in the course of phonetic implementation. Thus, the number of tones needed to specify a contour can be smaller than the number of syllables in the text. As a result, the model can account for the fact that the contours presented in Figure 9 are phonologically identical, although their phonetic forms are different (Ladd 1996:44).

![Figure 9](image)

**Figure 9:** Underspecification: phonologically identical analyses for phonetically different forms.

The example shows that the slope and the length of the transitions between the tonal targets depend on the number of intervening syllables. Thus, underspecification
allows the analysis to capture the similarity between the contours, because phonetic realisation is systematic.

Second, the difference in duration of the accented syllables does not need to be specified in the tonal analysis, as Mertens does, because the longer duration of pitch accents at the end of a prosodic constituent depends on the rank of the following constituent boundary. In other words, pre-final lengthening is a prosodic, and not a tonal phenomenon (cf. Chapter 6 section 6.4).

Third, the similarity between intonational forms can be expressed more transparently, because they are decomposed into separate tonal elements. For instance, the rising pitch movements on Laure and su in Figure 8 have the same pitch accent H*, but the difference in peak height is attributed to the H% boundary tone that follows the H* on su. As a consequence, fewer phonological categories are needed to account for the intonational forms. Thus, the analysis reflects the more general principle of economy in capturing all contrasts in the data by means of the smallest number of possible categories.

Fourth, the hope exists that an adequate phonological analysis will be readily interpretable in terms of morphemic units. The assumption is that the tone strings that characterise the intonation contours of the Intonation Phrase consist of (monotonal or polytonal) morphemes, each of which makes its own, independent contribution to the interpretation of the utterance (Gussenhoven 1984:193-258; Pierrehumbert and Hirschberg 1990). In this study, however, no attempt will be made to formulate such a functional, morphemic analysis.

In the remainder of this section, two Autosegmental-Metrical accounts that have been proposed for French are presented.

2.2.1. Jun and Fougeron

According to Jun and Fougeron (1995, to appear), French intonation is organised into the three prosodic levels of the Accentual Phrase (AP), the Intermediate Phrase (ip) and the Intonation Phrase (IP), as is shown in Figure 10 (cf. Jun and Fougeron to appear).

![Figure 10: Illustration of Jun and Fougeron’s three-layered prosodic structure.](image-url)
The tonal specification of the AP is LHiLH*. The H* tone associates with the last full syllable of a lexical word, i.e. the syllable with the primary stress, and the Hi tone associates with the first or second syllable of the AP-initial content word, i.e. the syllable with the secondary stress. The ip has a phrasal tone (H- or L-) which is not associated with any particular syllable, and the IP is marked by a final boundary tone (L% or H%) and relatively large phrase-final lengthening and optionally a pause.9 In line with the approach taken by Pierrehumbert (1980), Jun and Fougeron assume that the phonetic realisation of the intonation contour is directly derived from the phonological representation, leading to a model with two levels of representation. At the phonological level, the tonal specifications of the AP (LHiLH*), the ip (L- or H-) and the IP (L% or H%) are specified, which are aligned with the text and implemented as a fundamental frequency contour at the phonetic level of representation. If a phonological tone fails to surface as a phonetic target (e.g. LHiLH* surfaces as LLH), this is accounted for by means of phonetic undershoot.

The main differences between this account and ours, which will be presented in Chapter 6, are the following.

- Jun and Fougeron distinguish between word-initial and word-final pitch movements (Hi versus H*); both are pitch accents in the present proposal.
- The tonal specification of the AP, LHiLH*, would appear to imply that all four tones belong to the same tonal morpheme. No such implication exists in our treatment, where the tone string is assembled from boundary tones, pitch accents and an L-tone, and the length of the tone string depends on the number of accents.
- In Jun and Fougeron’s model, the tones of the phonological specification are often unrealised. In the account proposed here, all phonological tones are phonetically implemented.
- Jun and Fougeron adopt an Intermediate Phrase with its tonal specification L- or H-, which is absent in the present account.

These differences will be discussed in Chapter 6, where it will be argued that Jun and Fougeron’s description cannot capture all phonological contrasts in French, and that the tonal specifications of the contours are sometimes unnecessarily complex (Section 6.4.1).

2.2.2. Di Cristo and Hirst

Di Cristo and Hirst assume that a three-layered prosodic structure mediates between the tonal and the segmental structures (Hirst and Di Cristo 1984; Di Cristo and Hirst 1993, 1996, 1997). This is exemplified in Figure 11 (adapted from Di Cristo et al. to appear). The lowest level of the Tonal Unit (TU; 3 in the figure) is delimited by an L tone at its left edge and an H tone at its right edge. Thus, each pitch movement has its own prosodic domain (i.e. one on un jo- and another on -li bateau), which domain does not necessarily coincide with word boundaries.

---

9 The tonal specification of the initial ip and IP boundaries are not discussed.
THEORETICAL BACKGROUND

1. Intonation Unit: [...]  

2. Rhythmic Unit: {...}  

3. Tonal Unit: (...)  

Derivation rules:

Figure 11: Illustration of Di Cristo and Hirst’s three-layered prosodic structure.

An alternative pronunciation with a pitch peak on -li instead of jo- is also possible. In this case, the first TU spans un joli, and the second bateau, and they coincide with word boundaries. At the intermediate level of the Rhythmic Unit (RU; 2 in the figure), differences in metrical strength are specified. They are implemented as differences in lengthening and do not affect the tonal structure. Each word-final pitch accent projects its own RU from right to left, including any preceding word-initial pitch accents in the same RU (Di Cristo and Hirst 1997). Thus, the two Tonal Units in un joli bateau in Figure 11 together form a Rhythmic Unit, and since the accented syllable -teau coincides with the boundary of the RU, it will have a longer duration. At the highest level, Tonal Units are organised into Intonation Units (IU; 1 in the figure), which are delimited by an LH or an LL tone sequence associated with their left and right edges, respectively. Thus, the L and H tones of the IU are comparable to the IP-initial and -final boundary tones of the other descriptions. A fourth unit is identified, somewhat comparable to Jun and Fougeron’s Intermediate Phrase, called Segment d’UI ‘segment of IU’ (not given in the figure). The Segment d’UI occurs in unfinished or interrupted utterances, or in extraposed sequences such as the underlined part in Ça lui ferait plaisir, une bonne bouteille de champagne (Di Cristo and Hirst 1996). The Segment d’UI in this example is characterised by low or high level pitch. Instead of forming an IU with its own LL or LH specification, the Segment d’UI copies the final tone of the preceding phrase Ça lui ferait plaisir (cf. Gussenhoven 1988).

10 The Rhythmic Unit in Figure 11 coincides with the Intonation Unit, but Intonation Units can contain more than one Rhythmic Unit.
The tones of the TU and IU are defined at the underlying level of the phonological representation, and transformed into a phonological surface form (MHDB in Figure 11) by means of a set of phonological rules. Thus, Di Cristo and colleagues distinguish two phonological levels (cf. Gussenhoven 1984, 1985). In addition, they distinguish a phonetic from a physical level of representation. At the phonetic level, the tones of the phonological surface representation (referred to as autosegments) are interpreted as a 'modelled' contour, which in turn is implemented in terms of fundamental frequency at the physical level (not presented in the figure; Di Cristo and Hirst 1996).

The most important differences between the account of Di Cristo and colleagues and ours are the following.

- The Tonal Unit is the minimal unit of tonal description in Di Cristo's and Hirst's account; its equivalent in the present analysis is probably the accented syllable, with which the (H+)* pitch accent associates.
- Di Cristo and Hirst adopt the Segment d'UI to account for intonation contours involving dislocated constituents; there is no equivalent in the present analysis.
- Instead of Di Cristo and Hirst's four levels of representation, the present account only has two.

In Chapter 6, it will be argued that the transformation between the phonological levels in Di Cristo and Hirst's account leads to some confusion about, for instance, the categorical or gradient nature of tonal differences (Section 6.4.2).

2.3. Reformulation of the research questions

The research questions of Chapter 1 can now be reformulated as follows:

I. Which pitch movements occur around stressed syllables and boundaries?
II. Which differences between pitch movements are categorical?
III. What is the inventory of pitch accents and boundary tones?
IV. Which positions in the prosodic structure do they associate with?

Hypotheses about gradient and categorical variations in pitch around stressed syllables and boundaries were drawn up on the basis of an auditory and acoustic analysis of two speech corpora, reported in Chapter 5. The third question is addressed in Chapter 6, where a tonal analysis with two pitch accents (H* and H+H*), five boundary specifications (%L, %H and L%, H%, 0%) and an optional L-tone is claimed to account for all and only the categorical differences identified in Chapter 5. Chapter 7 returns to the first two questions, as it investigates some predictions of our tonal analysis about categorical and gradient variation. The fourth question can in part be answered here. As was mentioned in the previous section, we assume that the Intonation Phrase is the domain of association of the boundary tone. The boundaries of Intonation Phrases are usually recognisable by the completion of a phonologically distinct pitch movement (internal criteria), the occurrence of a pause, final syllable lengthening, a drop in amplitude, and resetting of the register (external criteria; e.g. Vaissière 1983). Since the concept of the Intonation Phrase is relatively
uncontroversial in French, the issue of the mapping between Intonation Phrases and other levels of the grammatical structure will not be pursued in this study. However, conflicting claims have been made about the structure(s) relevant to the association of the pitch accents, as was pointed out in Chapter 1. Therefore, the formal definition of the domain which has been claimed to condition the distribution of pitch accents in French will be empirically investigated in Chapter 3, and the interaction between phrasing and pitch accent assignment will be described in a constraint-based analysis in Chapter 4.

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11 Boundaries of prosodic constituents below the Intonation Phrase have also been claimed to associate with a tone in French (Intermediate Phrase in Jun and Fougeron 1995, to appear, and the Segment d'UI in Di Cristo and Hirst 1996). In Chapter 6 section 6.4, it will be argued that this is not necessary.
Chapter 3  Pitch accents, Liaison and the Phonological Phrase: An experimental investigation

Recent treatments of French intonation claim that the Phonological Phrase accounts for the distribution of pitch accents, by which the pitch accent at the right edge of the Phonological Phrase is obligatory and other pitch accents are optional. The investigation presented in this chapter is primarily concerned with the question whether the prosodic domain that conditions this distribution of pitch accents can be defined on independent grounds. It has been claimed that the segmental process of Liaison motivates the existence of the Phonological Phrase in French, while more recently, the tonal phenomenon of Clash Resolution has also been advanced as being conditioned by the Phonological Phrase (Section 3.1). A production experiment was designed to investigate the application of Liaison and Clash Resolution (Section 3.2). The findings, reported in Section 3.3, call the claim that Liaison is bounded by the Phonological Phrase into question. The domain of application of Clash Resolution, by contrast, is the Phonological Phrase. Section 3.4 concludes this first part of the investigation.

The second part of this chapter addresses two questions that arose during the analysis of the data (Section 3.5). The first question concerns the optional restructuring of two Phonological Phrases as a single Phonological Phrase, which is assumed to account for cases in which the application of Clash Resolution is optional. Although the experiment confirmed the correlation between phonological phrasing and Clash Resolution, some of the Clash Resolution cases were found to conflict with the rules for the restructuring that have been proposed in the literature. Thus, it was no longer clear how optional restructuring of Phonological Phrases is governed by the syntactic structure. The question was, therefore, whether these cases can be accounted for on the basis of a revised definition of restructuring.

The second question concerns the nature of the phonological rule. In line with earlier accounts of the Rhythm Rule in English, French Clash Resolution has so far been described as a shift of the first accent to an earlier syllable in the word (Verluyten 1982; Hoskins 1994; Mazzola 1994). However, the data presented in this chapter strongly favour the view defended by Bolinger (1981), Gussenhoven (1987, 1991a) and Shattuck-Hufnagel (1991) for English that the process involves the deletion of the word-final pitch accent. Additional acoustic measurements were taken in the fundamental frequency traces of the production data which were compared with the perceptual judgements.

1 The part of this chapter concerned with restructuring and the phonological description of Clash Resolution has been published in Linguistics 37 (1999); the investigation reported in Sections 3.1 to 3.4 and the provisional account of Liaison proposed in Section 3.7 will appear in Probus 11 (2000).
The implications of these findings will be discussed in Section 3.6. In Section 3.7, a provisional suggestion for the account of Liaison is presented, in which the process has a syntactically defined domain of application, and is to be accounted for with the help of a lexical insertion process that takes precompiled forms from the lexicon.

3.1. Introduction

Traditionally, descriptions of French intonation assume that the prosodic domain that receives the full intonation contour in an utterance contains a sequence of Rhythmic Groups (Grammont 1966; Coustenoble and Armstrong 1934; Fouché and Dauzat 1935; Delattre 1966b; Ashby 1975). These lower level domains are claimed to account for the distribution of pitch accents. More specifically, at the level of the Rhythmic Group, some locations obligatorily receive a pitch accent, whereas other pitch accents are optional. In French, the rightmost full syllable of the lexical word is stressed and is a potential location for a pitch accent. The distribution of the pitch accents is given by the rule that only the pitch accent at the right edge of the Rhythmic Group is obligatory. In (1), the locations of the pitch accents are indicated by asterisks. The two Rhythmic Groups (RG) both receive an obligatory domain-final pitch accent; the first Rhythmic Group optionally has a second pitch accent on petit (given in brackets):2

(1)  (de petits enfants)RG (intelligents)RG  ‘small intelligent children’
   (*)  *  *

The Rhythmic Group has never been formally defined. Thus, no unequivocal way of decomposing an utterance into Rhythmic Groups has been put forward. However, in more recent treatments, the Rhythmic Group has been claimed to correspond to the Phonological Phrase (Verluyten 1982; Delais 1994), which has received a formal definition in the theory of Prosodic Phonology (Selkirk 1984; Nespor and Vogel 1986): the Phonological Phrase is a constituent of the Prosodic Hierarchy which is positioned between the Intonational Phrase and the Prosodic Word. As can be seen in (2) (based on Nespor and Vogel 1982: 228), the Phonological Phrase is derived from the syntactic constituent structure.3

(2)  Phonological Phrase formation rule
    A Phonological Phrase groups together a lexical head (X) with all the items on its non-recursive side (i.e. the left) within the maximal projection and with any other non-lexical item on the same side

---

2 Additional word-initial pitch accents, optional on in- in this example, will be discussed in Chapter 4.
3 Nespor and Vogel’s relation-based approach to the mapping between the prosodic and syntactic structure is presented here, as this is the view which has been adopted by Verluyten and Hoskins in their treatment of French Clash Resolution (Section 3.1.1). Selkirk’s end-based approach makes the same predictions about the domain of obligatory resolution of clashes, which would be the Small Phonological Phrase in Selkirk’s account (1986, 1995).
The application of the Phonological Phrase formation rule is exemplified in (3), where the two lexical heads are marked by a square bracket (PP stands for Phonological Phrase).

\[
\begin{align*}
(3) & \quad (de\ pets\ enfants)PP (intelligents)PP \\
& \quad (* \quad * \quad *)
\end{align*}
\]

In (3), each head forms a Phonological Phrase with all the material that precedes it. French pre-nominal adjectives cannot function as the heads of Phonological Phrases, and therefore *petits* in (3) does not form a Phonological Phrase on its own (Verluyten 1982; Nespor and Vogel 1986; Selkirk 1986). The rule for the distribution of pitch accents in the Rhythmic Group can now be reformulated by referring to the Phonological Phrase.

The central question addressed in this chapter is whether a motivation for the Phonological Phrase can be found which is independent of the rule for pitch accent distribution illustrated in (3). Two phonological processes have been claimed to operate within the Phonological Phrase.

Firstly, in common with English and German (Giegerich 1985) and many other languages, French has a specific accentual configuration that arises in stress clash contexts, which will be referred to as Clash Resolution (Garde 1968; Verluyten 1982; Dell 1984; Hoskins 1994; Mazzola 1994; Delais 1995). Clash Resolution is here interpreted as one of the factors that determine the distribution of pitch accents. Clash Resolution would be a strong diagnostic for Phonological Phrase structure. As will become clear in Section 3.1.1, Clash Resolution and the rule for pitch accent distribution illustrated in (3) occur in complementary contexts. Example (3) shows that the absence of a word-final accent signals the absence of a Phonological Phrase boundary, but the presence of a word-final accent does not necessarily entail the presence of a Phonological Phrase boundary, because lexical words that do not occur in Phonological Phrase final position can also have a word-final accent. Therefore, the 'default' distributional pattern of pitch accents illustrated in (3) is only a weak diagnostic for Phonological Phrase structure. By contrast, Clash Resolution would provide a strong diagnostic in those cases in which the stress clash context is present: if it applies, the prosodic structure must be such as to include that context in one Phonological Phrase, while if it does not, it must be distributed over two Phonological Phrases.

Secondly, the application of Liaison has been assumed to be conditioned by the Phonological Phrase (Verluyten 1982; Nespor and Vogel 1982; Booij 1986; Selkirk 1986; Booij and de Jong 1987; De Jong 1994). In fact, the domain relevant to the distribution of accents in French has been directly linked with the domain of application of Liaison (Pulgram 1965; Ashby 1975; Léon 1992), and Verluyten (1982) explicitly asserts that both Clash Resolution and Liaison are bounded by the Phonological Phrase.\(^4\)

---

\(^4\) However, adopting Martin's model of French intonation (1978), Morin and Kaye (1982) found that Phonological Words defined in terms of intonation patterns cannot be equated with the domain of Liaison.
Although several corpus studies have revealed cases that seem to be incompatible with this view (Ågren 1973; Morin and Kaye 1982; Encrevé 1988; De Jong 1994), the claim that Liaison provides evidence for the Phonological Phrase as a constituent of the Prosodic Hierarchy has evidently not disappeared from the literature.\(^5\)

In this chapter we intend, first, to provide independent phonetic evidence for Phonological Phrase structure. This evidence will be used to decide if either or both of the two processes at issue, Clash Resolution and Liaison, apply within the Phonological Phrase. Second, if the Phonological Phrase conditioning of at least one of these processes is confirmed, we intend to check whether the definition of the Phonological Phrase as given in (2) is empirically adequate. Obviously, if both processes are found to behave in the same way, and in conformity with the phonetic data, this finding will provide evidence for the Phonological Phrase as a prosodic constituent in French. However, if only one of them behaves in conformity with the phonetic data, the other process must be conditioned by other factors.\(^6\) Finally, if one or both processes apply within the Phonological Phrase as defined by the independent phonetic data, and the description in (2) fails to capture this domain, that description will need to be revised. We will not contemplate the consequences of any further types of incongruities.

A production experiment was designed to investigate the Phonological Phrase conditioning of Liaison and Clash Resolution (sections 3.2 and 3.3). The occurrence of Clash Resolution was established on the basis of the judgements of three trained phoneticians who were native speakers of French and the application of Liaison was established auditorily. In order to have independent evidence for the Phonological Phrase structure, vowel durations in the syllable before the monosyllabic word were measured. An analysis of the durations measured in the experimental conditions and a baseline control condition confirmed that in our experiment, pre-final durations for words that were followed by a Phonological Phrase boundary were significantly longer than those for words that are located Phonological Phrase internally (discussed in sections 3.2.1 and 3.2.3.1). The findings for Clash Resolution strongly support the claim that the distribution of pitch accents is sensitive to the Phonological Phrase as defined in the literature. However, the results show that Liaison is very unlikely to be conditioned by the Phonological Phrase. This means that Liaison cannot provide corroborating evidence for the Phonological Phrase as a prosodic constituent in French. The implications of these findings will be discussed in Section 3.4.

The following introductory sections present the claims that have been made in the literature that motivated the production experiment. Sections 3.1.1 and 3.1.2 discuss Clash Resolution and Liaison, respectively. The final section provides a summary statement of the ensuing predictions about the application of the two processes in the Phonological Phrase.

\[^5\] In their article, Morin and Kaye (1982) challenged Selkirk’s proposal to analyse Liaison as a deletion process that depends on the presence of word boundaries, which are defined by syntactic structure. It should be noted that this account of Liaison was not formulated in the framework of Prosodic Phonology.

\[^6\] The possible assumption that one of the rules is bounded by a domain at a different level of the prosodic hierarchy would be void: if a process applies at a higher level of the prosodic hierarchy, it should also apply at the lower level of the Phonological Phrase, and if either rule were confined to the Prosodic Word, there would be no context for it to apply in.
3.1.1. Clash Resolution

French has a specific accentual configuration that arises in clash contexts, here referred to as Clash Resolution (Verluyten 1982; Mazzola 1993, 1994; Hoskins 1994).\(^7\) Clash Resolution is similar to the Rhythm Rule in English and German and many other languages, a process which is also referred to as Stress Shift or Iambic Reversal (cf. Giegerich 1985). Clash is defined as the occurrence of adjacent word stresses. An example is given in (4).

\[
\begin{array}{ccc}
\text{Clash context:} & \rightarrow & \text{Rhythm Rule:} \\
\text{Japanese tables} & \* & \* \\
\end{array}
\]

\[
\begin{array}{ccc}
\text{Clash context:} & \rightarrow & \text{Clash Resolution:} \\
\text{de jolis airs} & \* & \* \\
\end{array}
\]

In cases such as \textit{de jolis airs} in (4), where a polysyllabic lexical word is followed by a monosyllabic lexical word within a Phonological Phrase, it is assumed that the phonological rule of Clash Resolution obligatorily applies to relieve the clash.\(^8\)

Analogous to the approaches to stress shift in English, three accounts of the pattern given in (4) can be proposed for French. In a pitch accent based account, the pattern would result from a process that affects phrase level pitch accent placement (Bolinger 1981; Gussenhoven 1987, 1991a; Shattuck-Hufnagel 1991). In Gussenhoven’s view, the apparent stress shift underlying the English Rhythm Rule results from the deletion of the final accent of the stress shift candidate, causing the initial pitch accent, which is independently present on the secondary stressed syllable before the primary stress, to stand out as the more prominent one. In a rhythm-based account, clashes are assumed to arise between rhythmically strong syllables whose relative prominence is represented in terms of a metrical grid. Such clashes result in a shift of the stress to an earlier syllable in the stress shift item (Liberman and Prince 1977; Hayes 1984). An alternative view is that the stress on the final syllable of the stress shift item is reduced, with the strengthening of another syllable being optional (Prince 1983; Selkirk 1984; Nespor and Vogel 1989; Vogel et al. 1995). For French, accentual patterns as in (4) have been claimed to result from a shift of the prominence (Verluyten 1982; Hoskins 1994; Mazzola 1994). Although the results from a pilot study reported in Hoskins (1994) suggest that there is a preference for two-accent patterns in clash contexts, it is not clear whether the presence of an initial accent on the stress shift item is obligatory (Verluyten

---

\(^7\) Mazzola (1993, 1994) describes Clash Resolution with reference to compounds and noun phrases exclusively, but does not mention the Phonological Phrase.

\(^8\) Clashes can also arise within Phonological Phrases between (a) a word-final and a word-initial stress, as in \textit{un grand événement} ‘a big event’, or between (b) two word-final stresses, as in \textit{un grand bal} ‘a big ball’. It seems that in such cases, the clash cannot be resolved unless one of the accents is not realised. Possibly, this process should be distinguished from the one illustrated in (4), and we will therefore not consider such clash contexts in the present investigation.
Fortunately the issue whether Clash Resolution involves the realisation of an initial pitch accent does not affect the assumption that the process is bounded by the Phonological Phrase. It is only the absence of the word-final accent on the stress shift item which is crucial to that assumption.

In addition to the obligatory application of Clash Resolution within Phonological Phrases, the process is claimed to apply optionally in phrases such as (5), in which the Phonological Phrase formation rule given in (2) predicts a Phonological Phrase boundary between the lexical heads. Note that in the usual pronunciation, *sages* is monosyllabic */sa3*/.

\[
\begin{align*}
{\text{des enfants}} & \qquad \{X^{\text{head}}\} \qquad \{X^{\text{head}}\} \\
{sages} & \qquad * \\
\end{align*}
\]

Verluyten (1982), basing himself on Nespor and Vogel (1980), accounts for such cases by assuming that French Phonological Phrases can optionally be restructured, a claim which Hoskins (1994) reiterates with some reservation. In general, restructuring has been proposed in order to account for phonological rules whose domain of application broadens under certain circumstances (e.g. *Raddoppiamento Syntattico* in Italian, Nespor and Vogel 1982, 1986; restructuring can capture the fact that the length of certain phonological constituents is relevant to the application of a phonological rule). Thus, the optionality of such rules is not a property of the rule itself, but of the restructuring of the phonological constituent (Nespor and Vogel 1986:172). The restructuring of Phonological Phrases is rigorously conditioned. Nespor and Vogel (1982:230) give a language-independent formulation of these conditions, here reproduced as (6).

\[\text{(6) Phonological Phrase restructuring rule}\]

A non-branching Phonological Phrase which is the first complement of \(X\) on its recursive side loses its label and is joined to the Phonological Phrase containing \(X\) under a new node labelled PP'

Since in French the recursive side is the right, *sages* in (5) is a candidate for restructuring with the preceding lexical head *enfants*. Restructuring can take place, because *sages* is the first complement of *enfants* and does not branch. In (7a), the

\[\ldots\]

---

9 In fact, the data presented in Section 3.5 show that in a relatively small number of cases, only the second pitch accent is realised, which conflicts with the shift-account of the French literature. Although Verluyten also adopts this view, he observes that in some variants of French, the initial accent can be suppressed altogether (Verluyten 1982:89).

10 The introduction of the restructured Phonological Phrase in French echoes similar proposals made to account for accentual patterns that were not formulated within the framework of Prosodic Phonology (Ashby 1975; Rossi 1985; Martin 1987; Mertens 1993b). Mazzola (1994) states that Clash Resolution is optional in Noun-Adjective sequences, but does not formalise his observations in the framework of Prosodic Phonology. Ashby (1975) also refers to the minor and the major Rhythmic Group to account for the variability in the application of Liaison.

11 Verluyten (1982: 390) argues that Nespor and Vogel's non-branching complement "n'est rien d'autre qu'un
original Phonological Phrase boundary is obliterated. As a result, a clash is created within a Phonological Phrase, and Clash Resolution has to relieve it. In (7b), the Phonological Phrases are not restructured and Clash Resolution is blocked as a result.

(7) a. \[des enfants sages\]PP’ b. \(des enfants\)PP \((sages)\)PP

In (8), by contrast, the complement of the first lexical head does branch, and therefore restructuring cannot take place.

(8) \((des hivers)PP\) \((autres qu’en Afrique)\)PP

‘winters different from (those) in Africa’

In sum, pitch accents can only be realised on immediately adjacent syllables if they belong to two different Phonological Phrases. Clash Resolution applies obligatorily within the Phonological Phrase and is optional across the boundaries of restructurable Phonological Phrases.

### 3.1.2. Liaison

Liaison is the phenomenon whereby a word-final latent consonant is pronounced as the onset of a following vowel-initial word (De Jong 1990). In (9a), Liaison applies between petit and ami (indicated by “!”), which means that the word-final /l/ in petit is pronounced. The latent consonant /l/ in petit (9b) is not pronounced (“?”), since it is followed by a consonant in garçon.

(9) a. petit = ami \(\rightarrow /petitarni/\) ‘small friend’

b. petit / garçon \(\rightarrow /petigarsō/\) ‘small boy’

Note that there is a set of words whose final consonants are always pronounced, regardless of their context (such as the final /l/ in the adjective mat /mat/ ‘mat’). This type of consonant is referred to in the literature as ‘fixed’ to distinguish it from the latent Liaison consonant.

#### 3.1.2.1. The representation of the Liaison consonant

Most non-linear phonological descriptions assume that latent consonants are ‘extrasyllabic’ elements in the underlying representation (Clements and Keyser 1983; Booij 1986; De Jong 1990).\(^\text{12}\) This means that latent consonants, unlike ‘fixed’

\(^{12}\) Apart from the extrasyllabic analysis presented here, several alternative analyses of the formal representation of the Liaison consonant have been proposed in the literature, for instance the deletion analysis (Schane 1968; Dell 1973, 1980; Selkirk 1974) and the insertion analysis (Tranel 1981); see Klausenburger (1984) and Tranel (1995) for an overview.
consonants, are marked by a feature that excludes them from the domain of core syllabification. Consequently, latent consonants are not automatically integrated into the syllable structure. In (10), the latent consonant of *petit* is not associated with a syllable node, unlike the word-final ‘fixed’ consonant /t/ in *patate* (example based on de Jong 1994: 98).

\[
\begin{array}{c}
\sigma \\
CVCVC \\
petit \\
\end{array}
\quad \begin{array}{c}
\sigma \\
CVCVC \\
patat \\
\end{array}
\]

In order to be phonetically realised, a latent consonant has to be assigned to a syllable. This will happen if the latent consonant is immediately followed by a vowel. It is then linked to the syllable node dominated by this vowel (Clements and Keyser 1983), as shown in (11).

\[
\begin{array}{c}
\sigma \sigma \\
CVCVC \quad VCV \\
petit \quad ami \\
\end{array}
\]

The association line between the syllable node and the C segment in (11) is introduced by the rule of Liaison.13 Extrasyllabicity thus accounts for the phonetic realisation of some consonants as opposed to the non-realisation of others.

### 3.1.2.2. The domain of Liaison

The realisation of Liaison consonants is constrained by contextual factors. In some cases Liaison is obligatory, in other cases it is optional and in other cases still, it is prohibited. Traditional approaches merely list the syntactic contexts in which Liaison applies (Grammont 1938; Delattre 1951, 1966c; Malécot 1977). Selkirk (1972, 1974), adopting the framework of X-bar syntactic theory, was the first to attempt to formalise the contexts in which Liaison consonants are realised by generalising over X-bar syntactic categories. On the basis of a corpus study, Morin and Kaye reject her analysis and conclude that “the traditional approach, according to which the syntactic environment in which a liaison occurs is defined category by category, and sometimes even word by word, appears to be essentially correct” (Morin and Kaye 1982:326; cf. Klausenburger 1984:77). Some more recent generative descriptions also claim that the application of

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13 Following Wetzels (1987) and Tranel (1986a), de Jong (1994) represents latent consonants as “floating” consonants, i.e. consonants without an underlying skeletal position. Floating consonants can be phonetically realised only if they acquire an X-slot in the underlying structure. This skeletal position is inserted by rule. The difference between this approach and Clements and Keyser's view presented here is that the pronunciation of a latent consonant depends on X-slot insertion instead of syllabification of the C-slot.
Liaison is directly sensitive to syntactic structure (Clements and Keyser 1983:102; Kaisse 1985), a position which is countered by Selkirk (1986) and de Jong (1990), who argue that, in some cases, the application of Liaison cannot be correctly predicted on the basis of the syntactic constituent structure.  

In the theory of Prosodic Phonology (Selkirk 1984; Nespor and Vogel 1986) Liaison is assumed to be restricted to certain prosodic domains that are indirectly derived from the syntactic surface structure (Verluyten 1982; Nespor and Vogel 1982; Selkirk 1986; Booij 1986; Booij and de Jong 1987; De Jong 1994). In fact, Liaison is claimed to motivate the existence of the Phonological Phrase as a prosodic constituent in French. As shown in (12), Liaison will apply within all four Phonological Phrases given, but not across Phonological Phrase boundaries. The Liaison consonants are put between hyphens in the phonetic transcription.

(12) (Ces petits enfants) (ont appris) (à parler) (le français)  
/šə pa̱ti-z-áfã  5-t-apri a parle la frãse/  
'These small children have learned to speak French'

As mentioned before, since pre-nominal adjectives cannot function as the heads of Phonological Phrases in French, ces petits in (12) does not form a Phonological Phrase on its own. Therefore, Liaison is predicted to apply obligatorily in petits enfants.

Selkirk (1974) states that Liaison is also possible between a head and a following complement, as in (13), but never formalised this generalisation within the framework of Prosodic Phonology.  

---

14 Kaisse (1985), for instance, proposes to account for the application of Liaison in terms of c-command relations. This means that, for Liaison to apply between two successive words a and b, word b must c-command word a. However, the conditioning of the application of Liaison through the notion of c-command wrongly predicts, for instance, that Liaison is not realised between a specifier and a prehead complement, e.g. *mes / excellents amis ‘my excellent friends’. As de Jong (1990) points out, here, the adjective excellents does not c-command the determiner mes. Selkirk 1986 also mentions the specific problem of prehead complements for the c-command account. See de Jong (1990) for a discussion of the contexts that are problematic for direct syntax-sensitive approaches.

15 Selkirk calls the Small Phonological Phrase the domain of unmarked Liaison (1986b:395). Assuming the X-bar theory of phrase structure (Jackendoff 1977), Selkirk (1986, 1995) distinguishes between two levels of morpho-syntactic structure that are relevant to Phonological Phrase formation: the maximal projection of a lexical word (N, V, or A), designated by Xmax (the Maximal Phonological Phrase), and intermediary projections, designated by X’ (the Small Phonological Phrase). Although she advocates an end-based approach to the mapping between the prosodic and syntactic structure, as opposed to Nespor and Vogel’s relation-based approach (1982,1986), their rules for Phonological Phrase formation make essentially the same predictions about the obligatory application of Liaison. De Jong (1994) adopts Selkirk’s approach.

16 According to Selkirk (1974), the application of Liaison in this context occurs exclusively in formal speech. However, as Trawel (1981:174-175) points out, this assumption is difficult to reconcile with the general observation that, as speech becomes more casual, phonetic interactions between words commonly increase. The findings from several corpus studies contradict Selkirk’s restriction (Ågren 1973; Morin and Kaye 1982; Booij and de Jong 1987; De Jong 1994). Selkirk (1984) suggests that in more formal styles of speech, Liaison is maintained by some rules that may be quite “grammaticized” or “syntacticized” and no longer reflect the processes of “core phonology”.
Both Verluyten (1982) and Booij and de Jong (1987) propose the restructured Phonological Phrase discussed in the previous section to account for the optional realisation of Liaison consonants, and de Jong (1990, 1994) does so by referring to the Maximal Phonological Phrase, defined by Selkirk for a number of other languages (1986, 1995). The restructured Phonological Phrase is very similar to Maximal Phonological Phrase, since both group together a head (X = N, V, A) with its following direct complement. Following Selkirk's observation (1974, 1986), de Jong stipulates that for Liaison to apply, the head must be inflected. For the purpose of the present experiment, we will therefore assume that the conditions on restructuring in French can be formulated as in (14).

(14) Conditions on restructuring
Two contiguous Phonological Phrases can be restructured into one Phonological Phrase iff
a. the second PP is the first complement on the recursive side of the first PP's lexical head, and
b. the second PP is prosodically non-branching, and

c. the lexical head of the first PP is inflected.

If the conditions in (14) are met, restructuring can take place. In (15a), the original Phonological Phrase boundary is obliterated and Liaison applies, whereas in (15b) the Phonological Phrase boundary between enfants and intelligents blocks Liaison.

(15) a. \( \text{(des enfants)PP (intelligents)PP} \)  
\( /\text{de-z-afā ētelizā}/ \)

b. \( \text{(des enfants)PP (intelligents)PP} \)  
\( /\text{de-z-afā z-ētelizā}/ \)

If the conditions in (14) are not met, as in (16), restructuring is impossible. Consequently, the Liaison consonant between hivers and autres cannot be realised.

(16) \( \text{(des hivers)SPP (autres qu'en Afrique)SPP} \)  
\( /\text{de-z-iver otr kānafrik}/ \)

A number of objections can be raised against this prosodic account of Liaison. Firstly, the counter-arguments to Selkirk's original proposal put forward by Morin and Kaye (1982) would for the larger part also seem to apply to the Phonological Phrase as the domain of obligatory Liaison. Secondly, several studies suggest that Liaison is

---

17 Nespor and Vogel's and Selkirk's approaches make slightly different predictions. In Selkirk's view, des robes en dentelle 'lace dresses' would count as a Maximal Phonological Phrase, whereas according to Nespor and Vogel, it would not be restructurable, because the Phonological Phrase en dentelle branches.

18 For instance "Liaison after pre-nominal adjectives is rather systematic, but statistically, it cannot be
sensitive to word category, syntactic category, word length, word frequency, the nature of the latent consonant and of the preceding segment (e.g. Tranel 1981; Morin and Kaye 1982; Encrevé 1983; Booij and de Jong 1987), factors which are incompatible with the prosodic account of Liaison. And finally, Morin and Kaye’s finding that pauses can occur before and after the Liaison consonant probably provides the strongest argument against the assumption that Liaison is bounded by the prosodic structure (1982; also Ågren 1973 cited by Morin and Kaye, and Vinay 1976). Nevertheless, a number of authors continue to adhere to this assumption. For instance, Booij and de Jong (1987) and de Jong (1990) conclude that Liaison is highly sensitive to pauses on the basis of their corpus study, and claim that Liaison is bounded by the Phonological Phrase, and Mazzola (1993) argues that there is a direct relation between the metrical structure, derived on the basis of syntactic constituency, and the behaviour of the Liaison consonant. The hypothesis that Liaison applies obligatorily within Phonological Phrases, whether restructured or not, has, to our knowledge, not been investigated empirically within contexts defined on the basis of the algorithm for Phonological Phrase formation.

3.1.3. Summary

On the basis of the literature, the following predictions about the application of Liaison and Clash Resolution can be made:

I. Liaison and Clash Resolution apply obligatorily within Phonological Phrases, as illustrated in (17) below. Of course, in order for this prediction to be testable, the relevant conditions on the application of the rules should be met, i.e. Clash Resolution does not have to apply if there is no clash context (as in petits enfants), while Liaison cannot apply before a consonant (as in petits garçons ‘small boys’).

\[
(17) \ (de \ jolis = \ airs)PP \quad /d\ 3oli-z-\epsilonrz/
\]

II. Neither process applies across the boundaries of non-restructurable Phonological

considered obligatory; its (infrequent) omission is possible in all contexts but is more frequent when the liaison consonant is not the plural z, …” (Morin and Kaye 1982:295; cf. Klausenburger 1984). A potentially fatal argument, which has, however, not been raised against the approach presented here, is discussed in Tranel (1990). Tranel claims that Liaison is obligatory in dislocated constituents of the type j’en ai un, ami. ‘I clitic-have one, friend’ (cf. Morin and Kaye 1982 for Quebec French), in which the algorithm for Phonological Phrase formation would predict a boundary between un and ami (which would coincide with an Intonational Phrase boundary). Although Tranel states that such dislocations are accepted by some speakers of standard French, it has not been attested in French grammars (e.g. Grévisse 1993), as he points out himself (1990:174 footnote 8). My French informant suggested that the perception of an apparent break between the constituents may be attributable to the focalisation of the word that precedes the boundary. For the present, we will therefore not adopt dislocation as a valid counter-argument.

19 De Jong (1994) proposes to account for the variability of Liaison by assuming that the Liaison consonant has been lexicalised. The insertion of the Liaison allomorph depends on the prosodic constituent structure, for which he adopts Selkirk’s approach (see section 3.7 for a discussion of de Jong’s proposal).
Phrases, as in (18).

\[(18) \ (\text{des hivers}) \text{PP (autres qu'en Afrique)} \text{PP} \]
\[
\begin{array}{ccc}
\ast & \ast & \ast \\
/\text{de-z-iver} & \text{otr kānafrik}/
\end{array}
\]

III. Since Phonological Phrase restructuring is optional, both Liaison and Clash Resolution apply optionally, but in tandem, across potentially restructurable Phonological Phrase boundaries. If restructuring is signalled by the application of one process, it should also surface in the application of the other process. That is, we expect to find the application of Liaison to coincide with the application of Clash Resolution, as in (19a). If no restructuring takes place, neither rule should apply, as in (19b).

\[(19) \ a. \ (\text{des hivers} \text{ après}) \text{ PP'} \quad b. \ (\text{des hivers}) \text{PP (après)} \text{PP} \; \text{'bleak winters'} \]
\[
\begin{array}{ccc}
\ast & \ast & \ast \\
/\text{de-z-iver-z-aprä} & /\text{de-z-iver apr}/
\end{array}
\]

A production experiment was conducted to verify these predictions.

3.2. Method

The experiment was designed to test the claims that the Phonological Phrase (as defined in Prosodic Phonology) adequately predicts the realisation of Liaison and Clash Resolution, and that restructuring accounts for the variability in the application of both Liaison and Clash Resolution. On the basis of these claims, we hypothesised that

Hypothesis I: The application of both Clash Resolution and Liaison are **obligatory** within the Phonological Phrase and **prohibited** across Phonological Phrase boundaries

Hypothesis II: Restructuring should be reflected in the **cooccurrence** of the rules within the restructured Phonological Phrase

The hypotheses were tested in three phrasing conditions: (a) the Phonological Phrase, (b) a sequence of non-restructurable Phonological Phrases, and (c) a sequence of restructurable Phonological Phrases. Table 1 presents an overview of the predictions in the three conditions.

In the first column in Table 1, the conditions are listed; the second and third columns give the possible realisations of Liaison and Clash Resolution, while the last column gives the phonological status of the target phrase concerned. Each row gives a legitimate combination of the application or non-application of the rules. In the following sections, we first describe the materials, then the testing procedure, and finally the way in which the data were analysed.
**Table 1:** Summary of predictions for each of the experimental conditions. "+" stands for application, "−" for non-application of the rule.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Liaison</th>
<th>Clash Resolution</th>
<th>Target phrase type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+</td>
<td>+</td>
<td>Phonological Phrase</td>
</tr>
<tr>
<td>2</td>
<td>−</td>
<td>−</td>
<td>Restructuring impossible</td>
</tr>
<tr>
<td>3</td>
<td>+</td>
<td>−</td>
<td>Restructuring optional</td>
</tr>
</tbody>
</table>

3.2.1. Materials

In order to elicit phonological phrasing as predicted by Prosodic Phonology in the experimental conditions, syntactic constituency and number of words were varied as follows:

Condition 1: Phonological Phrase: a lexical head (noun) preceded by a non-head (adjective)

Condition 2: Non-restructurable Phonological Phrases: a sequence of an inflected lexical head (noun) and its direct complement (a branching lexical head; adjective or adverbial phrase)

Condition 3: Restructurable Phonological Phrases: a sequence of an inflected lexical head (noun) and a non-branching complement (adjective)

There are two factors that needed to be controlled for in the materials. Firstly, the Structural Descriptions of Liaison and Clash Resolution had to be met in the experimental items. Thus, in order to elicit Clash Resolution, the target word contained two syllables and the following word was monosyllabic (i.e. a clash context was created), and in order to elicit Liaison, the first lexical word in each item - the target word - ended in a latent consonant and the following word began with a vowel. We tried to take into account the counter-arguments to the prosodic analysis of Liaison mentioned in Section 3.1.2.2 in the construction of the materials, so as to create contexts in which Liaison was most likely to apply. We tried to compensate for the factors word category, syntactic category, and the nature of the latent consonant as follows. Within the Phonological Phrase (Condition 1), all items consisted of an adjective followed by a noun, both plural, because Liaison is more likely to occur in noun phrases than in verb phrases and is more likely after plural than singular pre-nominal adjectives (Delattre 1951; Malécot 1977; Morin and Kaye 1982). We selected sequences of a plural noun followed by an adjective for the restructurable Phonological Phrase (Condition 3) for the same reasons, but also because Morin and Kaye state that Selkirk’s inflectedness requirement may only be relevant for nouns (Morin and Kaye 1982:313). For items to be comparable across conditions, the non-restructurable sequences (Condition 2) had to be minimally different, and therefore consisted of a plural noun followed by an adjectival phrase or an adverbial phrase. Although the noun was always followed by a complement, we allowed for some variation in the syntactic relations holding between...

---

20 The application of Liaison could not be tested by means of determiners, after which Liaison is most frequent, because in that case, the context would not have met the Structural Description of Clash Resolution.
the two (see Appendix A1), which according to the theory of Prosodic Phonology should not affect Phonological Phrasing.\footnote{An anonymous reviewer for Probus suggested that restructuring is sensitive to the exact nature of such syntactic relations. It would be an interesting point to pursue, which is however not the aim of the present investigation. For our experiment, expert judgements and durational measurements seem to indicate that this view is not warranted, as will be shown in section 3.2.3.2.} Finally, we tried to select only words which fall within the group of 5000 most frequent words in standard French to compensate for word frequency (Juilland et al. 1970).\footnote{Evidently, some variability, not only in word frequency, but also in the nature of the segment preceding the Liaison consonant, could not be avoided. Thus, as an anonymous reviewer pointed out, hivers and divers (item 3 in Appendix A1) have a final fixed consonant /r/ before the latent plural /z/, a factor which has been reported not to favour Liaison (Tranel 1981; Morin and Kaye 1982). We have tried to take such factors into account by keeping the characteristics of the target words as constant as possible across conditions. However, according to the prosodic account of Liaison, the variability in the materials should not affect the process.}

Secondly, the durational analysis that served to verify whether the realisations in the experimental conditions did indeed reflect phonological phrasing as predicted by Prosodic Phonology imposed restrictions on the materials. Several studies have confirmed that durational variation is in part a function of the relative strength of a prosodic boundary, as shown for French by Crompton (1980), Wenk and Wioland (1982), Pasdeloup (1992a), Vaisière (1992) and Delais (1995). This means that pre-final durations measured for words that are followed by a Phonological Phrase boundary are longer than those for words that are located Phonological Phrase internally. In order to allow for a valid comparison of segmental durations across conditions, the segmental material in the target word was kept as constant as possible, thereby eliminating intrinsic durational effects due to the properties of segments (e.g. /i/ has a shorter duration than /a/). In items 1 to 8, only the word-initial consonant in the target word varied (e.g. jolis/folies/colis); in item 9, the consonant intervening between the vowels in the target word varied as well (mauvais/projets/forêts) (see Appendix A1).

However, having eliminated intrinsic durational effects, in our data the duration of the final syllable of the target word may still be lengthened by the presence of a Liaison consonant or, in cases of non-resolved clash, of a pitch accent on that syllable.\footnote{Evidently, the occurrence of Liaison and Clash Resolution varied between the conditions.} We tried to minimise the effect of Liaison by subtracting the duration of the Liaison consonant from the duration of the word-final syllable whenever Liaison was realised. As this subtraction may disproportionately reduce the effect of final lengthening within the Phonological Phrase (i.e. in Condition 1 in which Liaison is expected to apply without exception), we decided to include a Control Condition in which the Structural Description of Liaison was not met, and contrast segmental durations in the Control Condition with durations in both Condition 1 and Condition 2.\footnote{We would like to point out that we did not expect this possible reduction to be significant, because pre-final lengthening has been reported to affect the duration of the vowel of the pre-final syllable rather than that of a following consonant (Crystal and House 1988). Furthermore, Delattre (1966a) found that although closed syllables are significantly longer than open syllables irrespective of their position in the Rhythmic Group, the ratio of syllable lengths between closed and open syllables does not depend on the position of the syllable in the Rhythmic Group. He therefore concludes that "if a syllable is longer than another, both its consonants and its vowels are proportionately longer" (1966a:189). Note, though, that the Liaison-consonant is generally assumed to syllabify with the following vowel.} The items in the
Control Condition contained a modifier followed by the adjective used in Condition 1 (viz. the target word, here singular instead of plural) and a noun that together formed Phonological Phrases (e.g. sa plus jolie jupe 'her prettiest skirt'). Since the word following the target word began with a consonant, Liaison could not apply, and durations in the Control Condition should be very similar to the 'subtracted' durations in Condition 1, while both should be significantly different from durations in Condition 2.

The lengthening effect of pitch accents on the duration of the syllable could not be compensated for in such a way in the Control Condition. We tried to reduce the likelihood of pitch accents on the syllable concerned by positioning the target word between two monosyllabic words that are assumed to each attract a pitch accent, but such occurrences cannot be excluded altogether. However, any such pitch accent can only serve to increase the mean durational difference between Condition 1 and the Control Condition, and thus can only have biased our results in a direction away from the hypothesis being tested.

A corpus containing four data sets was constructed. Each data set consisted of nine items. All items were embedded in carrier sentences, such that they were never positioned at the beginning or the end of an utterance (see Appendix A1), in order to avoid interference from utterance initial or final prosodic phenomena. In addition, 30 fillers were included.

3.2.2. Subjects and procedure

The corpus was recorded on DAT-tape in a sound-treated room in the Phonetics Laboratory of the University of Paris III. The carrier sentences were presented in a quasi random order, double spaced, on A4 size paper, covering three pages in all. No punctuation marks appeared in the vicinity of the items. The initial and final sentences on each page were fillers. Two versions of the corpus with different random orders were prepared to control for order effects.

We recruited twenty-two native speakers of French, ten men and twelve women, from the student population of the University of Paris III. They were aged between 20 and 30 and came from the Paris region. Half of the men and women were presented with the first version of the corpus, the other half with the second. The speakers were instructed to read the carrier sentences at a normal pace and take some time between sentences (see Appendix A2). The recordings of eighteen speakers were included in the analysis (nine men and nine women). Although prior to the recordings, all speakers indicated that they came from Paris, two speakers later said that they had not always lived in the Paris area. Two others turned out to have serious reading problems.

3.2.3. Analysis

The data were digitised at 16 kHz on a Silicon Graphics IndyTM workstation and analysed auditorily and acoustically with the help of the Entropic waves+TM signal processing package.
3.2.3.1. Acoustic analysis
In every item, durations were measured in a wide-band spectrogram from the onset of the second vowel of the target word to the onset of the following vowel; the onset of the second formant was taken as the starting point of the vowel. This is exemplified in Figure 1.

![Soundwave, pitch track, and spectrogram](image)

Figure 1: Soundwave (top), pitch track (centre) and spectrogram (bottom) of *de mauvais ordres* 'bad orders' produced by speaker 3, with phonetic transcription given. The arrows in the spectrogram indicate the onset of the word-final vowel of *mauvais* and the onset of the following vowel in *ordres*.

The arrows in the spectrogram in Figure 1 mark the interval that was measured (here from the onset of /e/ in /movez/ to the onset of /ɔ/ in /ordr/). When a Liaison consonant intervened between the vowels, as indicated by the fricative energy in the higher formants (always /z/; see spectrogram Figure 1), its duration was measured separately and subtracted from the vowel-to-vowel interval.

3.2.3.2. Perceptual analysis
The application of Liaison in the experimental conditions was established auditorily (by the author). In order to assess where Clash Resolution had been applied, three trained phoneticians, all native speakers of French, were asked to judge the realisations of the items in the experimental conditions. The items were grouped per speaker, and each group was presented in one of three different random orders. Eleven fillers (phrases
without clash contexts) were included per speaker to increase the variety of the materials. A test tape with a total duration of 90 minutes was prepared. After one second, the item was repeated, the next item starting 4.5 seconds after the repetition. On the score form, a written instruction asked the judges to indicate the most prominent syllable in the target word (which was underlined) by ticking the appropriate box (labelled “initial” and “final”; all target words were bisyllabic). An extract of the score form with the instructions is included as Appendix A3. Only cases in which at least two out of the three judges agreed were counted. As a result, fourteen cases had to be discarded. Of the 471 judgements for Clash Resolution that were thus obtained, 180 were unanimous (38%; there was one missing item in Condition 2). As the analysis involved three judges which could each make three different judgements (“initial”, “final”, or “equally prominent”), we decided to assess whether the obtained agreement was due to chance by calculating Fleiss Kappa (Rietveld and Van Hout 1993). The outcome of the statistical test was highly significant: K=0.31 (the range of possible values of kappa is 0-1), with Z=16.098, p<0.01. Although the value of kappa is not high, we must reject the hypothesis that the agreement was the result of a chance process.

The data in Condition 2 had to be subjected to a supplementary judgement. Although restructuring should not have occurred at all, a preliminary auditory and acoustic analysis indicated that speakers did not always realise a phrase break between the noun and the following adjective or adverb. As a result, the phonological phrasing elicited in Condition 2 did not always reflect the phonological phrasing required for testing the application of Liaison and Clash Resolution. The judgements of the same expert judges served to establish which realisations needed to be excluded from the analysis. For this purpose, the test tape mentioned in the previous paragraph presented the items in Condition 2 and those in Conditions 1 and 3 in two separate blocks. On the score form, the block of items in Condition 2 was preceded by a written instruction in which the judges were asked to indicate not only the most prominent syllable in the target word, but also the location of the strongest juncture in the items (also included in Appendix A3). As before, the agreement between the judges was significant (57% of 161 cases; Fleiss kappa = 0.64, Z=19.319, p<0.01). The judgements indicated that in 101 cases (63%), the strongest prosodic boundary occurred after the noun, i.e. at the location predicted by the algorithm for Phonological Phrase formation (see Appendix A4 for an overview of the counts per item). A between-speaker analysis showed that all speakers produced restructured realisations, except for speaker 16 who consistently produced a phrase break at the predicted location. An analysis of the judgements per item showed that the number of restructured cases varied between items, but that all items were realised with a prosodic boundary after the noun in a substantial number of cases. Although items 4, 6, 7 and 9 seemed to be more sensitive to restructuring, the “aberrant” realisations do not seem to be attributable to differences in the precise
syntactic relations holding between head and complement, such as the occurrence of non-restrictive versus restrictive adjectival phrases (compare items 2 and 8 with 1 and 4 in Appendix A1).

A separate statistical analysis was performed to verify whether the judgements of the phrase breaks in Condition 2 were confirmed by the duration measurements. The results showed that the mean vowel-to-vowel duration in the 56 restructured cases is significantly smaller than that in the non-restructured cases (two-tailed independent samples t-test: $T_{1.154.64}=4.16$, $p<0.001$). This means that pre-final lengthening supports the judgements, and the 56 restructured realisations plus the 4 disagreement cases in Condition 2 were excluded from the analysis.

3.3. Results

The number of applications of Liaison and Clash Resolution was counted in each experimental condition, in order to establish whether Liaison and Clash Resolution always applied in tandem. The results showed that in a substantial number of cases (112 out of 425 cases), the rules did not behave in the same way. In Condition 1, one of the rules applied when the other did not in 22 out of the 162 cases (17 cases of Clash Resolution without Liaison), which contradicts Hypothesis 1 that both processes apply obligatorily within the Phonological Phrase. In Condition 3, the number of conflicting cases is even higher; in 81 out of 162 cases only one process is applied (78 cases of Clash Resolution without Liaison). This finding contradicts Hypothesis 2 that restructuring is reflected in the co-occurrence of the rules. Only the results for Condition 2, in which in 9 cases one of the rules applied across the Phonological Phrase boundary, do not seem to conflict with the hypothesis that Liaison and Clash Resolution are bounded by the Phonological Phrase (7 cases of Clash Resolution without Liaison). Figure 2 below illustrates the conflicting results. Speakers 12 and 13 produce the expected co-application of the rules, while the realisations of Speakers 2 and 10 contradict the expectations. Separate between-items and between-subjects analyses showed that there was no reason to assume that the conflicting cases can be attributed to specific items or subjects.²⁸

²⁷ The four cases in which the judges did not agree on the location of the strongest juncture were excluded from the analysis. The unequal variances approach is reported, since Levene’s homogeneity test was found to be highly significant.

²⁸ The application of both Liaison and Clash Resolution was found to be variable between items within each condition, but also, to a lesser extent, across conditions (see tables 2 and 3 below for the results per item). It should be noted, however, that the items which seemed to resist Liaison (items 2, 3, 4 and 5 in particular) did not correspond to those that were realised without Clash Resolution (items 8 and 9 in Condition 1 and items 1, 2, 3, 5 and 6 in Condition 3).
Speaker 13
/ l e m e ü -z- ivr /

Speaker 12
/ l e m e ü -Ø -ivr /

Speaker 2
/ l e m e ü -Ø -ivr /

Speaker 10
/ l e m e ü -z- ivr /

Figure 2: Realisations of the phrase *les méchants ivres* ‘the drunk villains’ by four speakers with schematic representation of pitch trace shown: speaker 13 applies both Liaison and Clash Resolution, speaker 12 applies neither rule, speaker 2 applies Clash Resolution only, and speaker 10 applies Liaison only.

Since our results show that the processes do not behave in the same way, the question arises whether the rules were actually tested in experimental conditions that reflect phonological phrasing as predicted by Prosodic Phonology. If so, is in fact only one of the rules bounded by the Phonological Phrase? In the following subsections, we will first report the statistical analysis that served to verify whether pre-final lengthening confirmed the Phonological Phrase structure of Conditions 1 and 2. Then the results for Conditions 1 and 2 will be discussed for each process separately. Finally, we will present the results for Condition 3, in which phonological phrasing was variable (i.e. restructured or non-restructured).

3.3.1. Pre-boundary lengthening in Conditions 1 and 2

The segmental durations in the Control Condition and Conditions 1 and 2 were contrasted to verify the assumption that pre-boundary lengthening reliably indicates the presence of Phonological Phrase boundaries in the present production experiment. In Figure 3, mean vowel-to-vowel durations in the three conditions are reported. As can be seen in the figure, durations measured in non-restructured Phonological Phrases (Condition 2) are considerably longer than those within Phonological Phrases (Conditions 1 and Control) (368 ms. versus 134 ms. and 156 ms., respectively).
Figure 3: Mean durations of vowel-to-vowel intervals measured in Condition 1, Condition 2 and the Control condition. The scores were pooled over items and speakers (112 observations in each condition).

An analysis of variance (repeated measures, SPSS-MANOVA)\(^{29}\) revealed a significant main effect for CONDITION (3 levels; Huynh-Feldt corrected F\(_{1.18}\) = 254.33, \(p < 0.001\)). A post-hoc analysis (Tukey’s HSD, significant at the 5% level) showed that the data fell into two subsets: (a) Condition 1 and the Control Condition, and (b) Condition 2. In other words, durations measured within the Phonological Phrase (Condition 1 and Control Condition) are significantly different from those measured before a Phonological Phrase boundary (Condition 2).

3.3.2. The Phonological Phrase boundedness of Liaison and Clash Resolution (Conditions 1 and 2)

Now that it has been established that pre-boundary vowel-to-vowel duration is a statistically reliable indicator of Phonological Phrase structure, vowel-to-vowel duration can in principle be used as a check on the Phonological Phrase boundedness of Clash Resolution and Liaison respectively. For each experimental condition, we recorded the number of applications of Liaison and Clash Resolution separately. Table 2 gives the counts for Conditions 1 and 2.

The table shows that the realisation of Liaison conflicted with the hypothesis that the process is bounded by the Phonological Phrase in a total of 22 cases in Conditions 1 and 2. Two conflicting cases were produced in Condition 2, while Liaison was not applied in 20 cases in Condition 1, where it should have applied without exception. This finding was found to be significant if one allows a 5% margin for “mistakes” (\(Z = -4.47, p < 0.01\) with \(\pi = 0.95\)). Furthermore, a clearly audible short pause was realised before or after the Liaison consonant in 5 realisations in Conditions 1 and 3 (the items and

\(^{29}\) Scores were pooled over items. For each speaker, the items in Condition 1 and the Control Condition that corresponded to the missing items in Condition 2 (i.e. the 56 restructured phrases) were excluded from the analysis.
speakers concerned were different in all cases). The results for Clash Resolution were compatible with the claim that the process is bounded by the Phonological Phrase, since there were only a few conflicting realisations in Condition 1 (6 cases) and Condition 2 (7 of cases).

### Table 2: The number of applications of Liaison (top) and Clash Resolution (bottom) in each item of conditions 1 and 2. For Clash Resolution, “=” indicates equal prominence judgements and “?” indicates disagreement cases.

<table>
<thead>
<tr>
<th>Item</th>
<th>Liaison</th>
<th>Condition 1</th>
<th>Liaison</th>
<th>Condition 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>jolis airs</td>
<td>yes</td>
<td>18</td>
<td>0</td>
<td>colis ocre</td>
</tr>
<tr>
<td>damnés œufs</td>
<td>yes</td>
<td>11</td>
<td>7</td>
<td>damnés ivres</td>
</tr>
<tr>
<td>divers âges</td>
<td>yes</td>
<td>15</td>
<td>3</td>
<td>hivers autres</td>
</tr>
<tr>
<td>charmants oncles</td>
<td>yes</td>
<td>16</td>
<td>2</td>
<td>sarments aptes</td>
</tr>
<tr>
<td>anciens os</td>
<td>yes</td>
<td>16</td>
<td>2</td>
<td>anciens aptes</td>
</tr>
<tr>
<td>méchants actes</td>
<td>yes</td>
<td>14</td>
<td>4</td>
<td>méchants ivres</td>
</tr>
<tr>
<td>premiers hommes</td>
<td>yes</td>
<td>17</td>
<td>1</td>
<td>premiers aptes</td>
</tr>
<tr>
<td>derniers actes</td>
<td>yes</td>
<td>17</td>
<td>1</td>
<td>derniers ivres</td>
</tr>
<tr>
<td>mauvais ordres</td>
<td>yes</td>
<td>18</td>
<td>0</td>
<td>projets aptes</td>
</tr>
<tr>
<td>Total</td>
<td>yes</td>
<td>142</td>
<td>20</td>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CR</th>
<th>yes</th>
<th>no</th>
<th>=</th>
<th>?</th>
</tr>
</thead>
<tbody>
<tr>
<td>jolis airs</td>
<td>16</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>damnés œufs</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>divers âges</td>
<td>15</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>charmants oncles</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>anciens os</td>
<td>17</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>méchants actes</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>premiers hommes</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>derniers actes</td>
<td>14</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>mauvais ordres</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>143</td>
<td>6</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

### 3.3.3. Liaison and Clash Resolution in restructurable Phonological Phrases (Condition 3)

In order to evaluate the Phonological Phrase boundedness of the processes in restructurable Phonological Phrases, the duration data for Condition 3 would have to be evaluated twice, once on the basis of the application of Liaison and once on the basis of the application of Clash Resolution, in order to see if, for either rule, restructuring is the factor that accounts for its application. In order to be able to do this for Liaison, the data would have to be divided into two groups depending on whether Liaison had
applied, but since in virtually all cases in which Liaison applied there was also an application of Clash Resolution (23 out of the 25 cases), such a check could unfortunately not be performed independently of Clash Resolution (an overview of the number of applications of Liaison and Clash Resolution in Condition 3 is included as Appendix A5). However, in a pilot experiment, it was found that such independent grouping of the data on the basis of Liaison could be achieved, and here no significantly different vowel-to-vowel durations were found in the two sets. In the case of Clash Resolution, by contrast, there was a large number of cases in the present experiment in which the rule was applied without simultaneous application of Liaison (48%) as well as a reasonably large number of cases in which neither Liaison nor Clash Resolution was applied (38%), so that an independent comparison for Clash Resolution was possible. Figure 4 gives the mean vowel-to-vowel durations of target words with and without Clash Resolution for the data in which Liaison did not apply.

![Figure 4: Mean vowel-to-vowel durations measured in target words with (+CR) and without (-CR) application of Clash Resolution in Condition 3, in data in which Liaison was not applied (total number of observations = 115).](image)

Figure 4 shows that the mean vowel-to-vowel duration in the data with application of Clash Resolution is substantially smaller than that in the data without (two-tailed independent samples t-test: $T_{1.46.45}=-4.27, p<0.001$). Although the mean durational difference is not as large as the difference observed between Conditions 1 and 2, the results in Condition 3 confirm that the application of Clash Resolution co-occurs with restructuring. We can therefore conclude that Clash Resolution is Phonological Phrase bounded.

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30 The unequal variances approach is reported, since Levene’s homogeneity test was found to be highly significant. As before, the cases in which no judgements on the application of Clash Resolution were made (i.e. cases of equal prominence or disagreement) have been excluded from the analysis.
3.4. Conclusion

In the present investigation, the application of two phonological rules that have been claimed to motivate the Phonological Phrase, Liaison and Clash Resolution, was experimentally tested. More specifically, the production experiment explored the hypotheses that (a) the application of both Clash Resolution and Liaison is obligatory within the Phonological Phrase and prohibited across Phonological Phrase boundaries, and that (b) restructuring is reflected in the co-occurrence of the rules within the restructured Phonological Phrase.

Evidently, the results did not support our first hypothesis. Although the application of Liaison and Clash Resolution across non-restructurable Phonological Phrase boundaries was excluded, Liaison did not apply within the Phonological Phrase as predicted. Our second hypothesis was not supported by the results either. Since Clash Resolution was found to apply without Liaison in the majority of items that potentially corresponded to restructured Phonological Phrases, the variability in the application of Liaison and Clash Resolution cannot be accounted for by means of the restructuring rules proposed in Prosodic Phonology. As will be clear from these findings, the claim that Liaison and Clash Resolution are both conditioned by the Phonological Phrase must be called into question. Logically, it may either be the case that the Structural Descriptions of neither rule makes reference to the Phonological Phrase, in which case the question arises what the evidence for this constituent is, or that only one of the rules is bounded by the Phonological Phrase, while the other operates in a different component of the grammar.

The production experiment showed that our findings are compatible with the claim that Clash Resolution is conditioned by the Phonological Phrase. Unlike Liaison, it applies virtually without exception in those situations where it is hypothesised to be obligatory. In other words, Clash Resolution is produced if a Phonological Phrase final accent follows a word-final accent, that is, in Condition 1 and the restructured cases in Condition 3. Moreover, Clash Resolution did not apply whenever a target word was followed by a Phonological Phrase boundary, that is, in the non-restructured cases in Conditions 2 and 3. In all three experimental conditions, these findings were confirmed by the duration measurements that were taken to serve as a cue for phrasing. This means that the findings for Clash Resolution provide strong support not only for the existence of the Phonological Phrase as defined by the theory of Prosodic Phonology, but also for the restructured Phonological Phrase as a prosodic domain in French. Accordingly, we conclude that Clash Resolution appears to be a 'true phrasal' rule, i.e. a postlexical rule that applies within a prosodically defined constituent.

The evidence for Liaison, by contrast, does not support the view that the contextual factors conditioning the process are prosodic in nature. In the introductory section, several findings were mentioned that seemed incompatible with the prosodic account of Liaison. It may therefore not be entirely surprising that Liaison was found not to apply in 12% of the cases where it was assumed to be obligatory, despite the fact
that several factors contributed to make the occurrence of Liaison more likely.\textsuperscript{31} This finding replicates the results of the pilot study conducted for this experiment, where Liaison failed to apply within the Phonological Phrase in 8% of cases, and supports Booij and de Jong's observation that Liaison is not always realised within the Phonological Phrase (1987:1006). Although the durational data in Condition 3 could not serve to independently establish whether the application of Liaison is reflected in restructuring, the pilot study conducted for this experiment clearly indicated that the application of 'optional' Liaison could not be accounted for on the basis of the restructured Phonological Phrase (see Section 3.3). Our results suggest that it is indeed Liaison which operates in a way different from what has been suggested in the literature.

We therefore conclude that, although the experiment provided clear results with respect to the sensitivity of distributional patterns of pitch accents to the Phonological Phrase, the segmental process of Liaison failed to provide corroborating evidence for the claim that the Phonological Phrase formation rule adequately defines the boundaries of the Phonological Phrase in French.

Yet, the experiment provided two interesting supplementary findings. Firstly, in 49 out of the 425 cases, the judges could not decide which syllable in the target word was the most prominent for a similar finding see Grabe and Warren 1995). This finding could be interpreted to suggest that the application of Clash Resolution does not necessarily entail the realisation of a word-initial accent. If so, the prevailing view that in French, clashes are resolved by means of a shift of the stress to an earlier syllable in the stress shift item may have to be abandoned. We decided to explore this possibility by subjecting the data to a supplementary analysis. Secondly, in Condition 2, where the complement is branching and where we should not have observed restructuring at all, it was nevertheless found that in 35% of the cases (56 realisations) judges indicated that the greatest prosodic boundary did not fall before the monosyllabic word, which indicates that restructuring had in fact taken place, calling the branchingness condition into question (Section 3.2.3.2). An analysis of the vowel durations in the syllable before the monosyllabic word in Condition 2 showed that their durational characteristics were consistent with the absence of a Phonological Phrase boundary in the 56 cases mentioned, and the presence of such a boundary in the 101 non-restructured cases. A reasonable assumption that can be made is that at least for French, the algorithm for Phonological Phrase restructuring presented in Section 3.1.1 is incorrect, and that branching complements, too, can restructure with their heads.\textsuperscript{32} The main purpose of the

\textsuperscript{31} Taking into account the factors mentioned in the literature that are assumed to play a role in the application of Liaison, the materials were constructed such as to favour elicitation of Liaison, and secondly, Liaison usually occurs more frequently in read than in spontaneous speech.

\textsuperscript{32} Our data do not allow us to draw any inferences about the factors that may have led to restructuring in Condition 2. Firstly, a between-speaker analysis showed that all speakers produced restructured realisations, except for speaker 16 who consistently produced a phrase break at the location predicted by the algorithms for Phonological Phrase formation. This means that the restructured cases could not be attributed to specific speakers. Secondly, an analysis of the judgements per item showed that the number of restructured cases varied between items, but that all items were realised with a prosodic boundary after the noun in a substantial number of cases. Although items 4, 6, 7 and 9 seemed to be more sensitive to restructuring, the restructured realisations were not attributable to differences in the precise syntactic relations holding between head and complement (such as the occurrence of non-restrictive versus restrictive adjectival phrases), nor to differences in length in
second part of this chapter is to show that this assumption is entirely justified. From the acoustic data and the data obtained from our expert judges a coherent picture emerges: branching complements may restructure, and when they do, Clash Resolution takes place.

3.5. Clash Resolution and restructuring

The unexpected finding that branching complements can also restructure with a preceding head raises the question if the restructurings in Condition 2, which were excluded from the analysis, are consistent with the view that the Phonological Phrase is the domain of Clash Resolution. In other words, is it the case that Clash Resolution takes place when there is restructuring and fails to take place when there is not? In view of the importance of this question, it was decided to supplement the experts' judgements with acoustic data. Selecting a reliable acoustic indicator of Clash Resolution is not entirely straightforward, as different phonetic parameters may be involved.

As mentioned in Section 3.1.1, all accounts of Clash Resolution in French assume that the metrical prominence of the word-final syllable of the first lexical word is shifted to the initial syllable, with subsequent docking of the pitch accent on the metrically strongest syllable (Verluyten 1982; Hoskins 1994; Mazzola 1994). An alternative view is that Clash Resolution involves the reduction of the stress on the final syllable of the stress-shift candidate. Yet, no evidence has so far been provided that indicates that rhythm-based approaches are better suited to account for the French data than a pitch-accent-based approach, in which the pitch accent on the final syllable is deleted. If an independently present initial pitch accent is realised, the deletion of the final accent causes this pitch accent to stand out more prominently. In all approaches, the accents indicated by the perceptual judgements should be reflected in the pitch trace, and the perceptual data on the optional application of Clash Resolution in Condition 2 can therefore be acoustically verified. Accordingly, the perceptual and acoustic data were compared in all three conditions.

3.5.1. Hypotheses

The second analysis aimed at exploring the following two questions:

I. Is the application of Clash Resolution as indicated by perceptual judgements reflected in the pitch trace?

II. Is restructuring of a lexical head and its branching complement possible, and, if so, are their accentual patterns compatible with the Phonological Phrase boundedness of Clash Resolution?

The first question was addressed by analysing the pitch traces of the items in the three experimental conditions. On the basis of previous phonological descriptions of Clash
Resolution in French, we assumed that Clash Resolution results in a shift of the word-final pitch accent on the first lexical word to the initial syllable. Since both word-initial and word-final pitch accents are claimed to be characterised by a rising pitch movement if they do not occur in utterance-final position (Delattre 1966b; Rossi 1985; Jun and Fougeron 1995; Di Cristo 1998), we hypothesised that sequences of two lexical words are consistently realised with two pitch peaks, the first of which is located on either the first or the second syllable of the first (bisyllabic) lexical word, depending on whether Clash Resolution has applied.

We addressed the second question by re-analysing the realisations of the items produced in Condition 2, including the 56 'aberrant' cases, for which the expert judges indicated that there was no phrase break after the first lexical word. It should be noted that the 'aberrant' realisations were produced for all items by seventeen out of eighteen speakers, which means that this finding could not be attributed to specific items or speakers. We assumed that the 'aberrant' cases were instances of restructured Phonological Phrases, which assumption was based on the finding that the durations measured in the items in which the Phonological Phrase boundary was judged to be located after the first lexical word were significantly longer than those measured in the 'aberrant' cases (Section 3.2.3.2). This finding replicated the consistent lengthening effect for phonological phrasing that was found in the other conditions. If we assume that the items in Condition 2 were in fact restructurable sequences of Phonological Phrases, we expect them to behave in a way that is similar to those in Condition 3 (restructurable phrases: a lexical head followed by a non-branching complement). We therefore hypothesised that Clash Resolution applies in all 'aberrant' cases.33

In sum, two further hypotheses were tested:

Hypothesis III: the application of Clash Resolution is reflected in the realisation of a word-initial as opposed to a word-final pitch peak.

Hypothesis IV: restructuring of a lexical head and its branching complement is reflected in the application of Clash Resolution

3.5.2. Acoustic analysis

Since our aim was to determine whether each item was realised with two pitch peaks, we decided to measure the highest fundamental frequency values in the vowels of the two lexical words. Two additional measurements were taken at the lowest point of the first and the third vowel, to establish the range of the rises to and from the accented syllables.34

33 For the 101 non-restructured cases, it has already been established that Clash Resolution only applied in 7 cases (not significant, see Section 3.3.2).

34 In order to determine at which locations fundamental frequency measurements should be taken, we first measured fundamental frequency at the beginning and the end of the four vowels of the items in Condition 1 (except for the final vowel in which only the highest point was measured). An analysis of variance (SPSS one-way ANOVA) showed that the difference between the mean values of the seven points was significant (F1,6=18.47, p<0.001). A post-hoc test (Tukey's HSD, significant at the 5% level) revealed that the differences measured within the first two vowels (points 1 - 2 and points 3 - 4, respectively) were not significant. On the
In Figure 5, stylised pitch patterns for realisations with and without the application of Clash Resolution illustrate pitch movements in the four vowels (indicated in grey).

<table>
<thead>
<tr>
<th>Clash Resolution has applied</th>
<th>de mauvais ordres</th>
</tr>
</thead>
<tbody>
<tr>
<td>dom o v e z o r</td>
<td>des hivers autres</td>
</tr>
<tr>
<td>de z i v e r o t r</td>
<td>(qu’en Afrique)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vowel intervals</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
</table>

**Figure 5:** Stylised pitch contours exemplifying the points at which fundamental frequency measurements were taken in the experimental conditions. The numbers represent the four vowels in which the measurements were taken.

The starting points and the end-points of the vowels were verified in a wide-band spectrogram, which was time-aligned with the pitch track (produced by means of the xwaves formant procedure) and the soundwave, as shown in Figure 6. The points at which the measurements were taken are indicated in the pitch track.

Halving and doubling errors were corrected as usual. The data in the three conditions were divided into three groups, depending on which point in the first lexical word was highest: (1) items in which the fundamental frequency measured at point 2 was higher than that at point 3 (i.e. a word-initial pitch peak on the first lexical word), (2) items in which it was lower at point 2 than at point 3 (i.e. a word-final pitch peak), (3) items in which it was the same at points 2 and 3.

Based on these findings, we decided to measure lowest and highest fundamental frequency points only, i.e. in the first and the second vowel of the item, only one point was measured.
Figure 6: Soundwave (top), pitch track (centre) and spectrogram (bottom) of *de mauvais ordres* ‘bad orders’ produced by speaker 3, with phonetic transcription given. The dots represent the 5 points in the vowels (V1 to V4) at which fundamental frequency was measured: (1) the lowest point in the first syllable, (2) the highest point in the second syllable, (3) the highest point in the third syllable, (4) the end-point in the third syllable, and (5) the highest point in the final syllable.

3.5.3. Results

A number of analyses were performed on the data in order to establish what the phonological phrase structure and accentual pattern of the items in Condition 2 were, and whether the pitch pattern reflected the application of Clash Resolution as perceived by the judges. In the first subsection, the perceptual evidence for restructuring in Condition 2 will be examined. In the second subsection, the results of a comparative analysis of the acoustic and perceptual evidence for Clash Resolution will be presented.

3.5.3.1 Phonological phrasing and accentuation in Condition 2

An analysis of the perceptual judgements of the phrase breaks in Condition 2 showed that the Phonological Phrase boundary was realised after the first lexical word in 101 cases, as in (20a), after the adjective or adverb in 40 cases, as in (20b), and in 16 cases
the speakers were judged not to have produced any phrase break within the item at all, as in (20c).\textsuperscript{35}

(20) a. No restructuring: \((\text{des hivers})\text{PP (autres qu’en Afrique)}\text{PP} \) (101 cases)

b. Restructuring 1: \((\text{des hivers autres})\text{PP (qu’en Afrique)}\text{PP}’ \) (40 cases)

c. Restructuring 2: \((\text{des hivers autres qu’en Afrique})\text{PP}’ \) (16 cases)

As is reported above, a significant difference in pre-final lengthening was observed between the first lexical word (i.e. \textit{hivers} in example 20) in realisations of the type given in (20a) on the one hand and those represented in (20b) and (c) on the other hand. This finding supported the judgements of the phrase breaks. It would be interesting to compare durations in the second lexical word as well, because we would expect to find a lengthening effect due to differences in phonological phrasing that would distinguish between the presence of a Phonological Phrase boundary after \textit{autres} in (20b) and the absence of such a boundary in (20a) and (20c). Unfortunately, no statistical analysis could be performed to investigate pre-final lengthening on the second lexical word. As the second lexical word was segmentally different across items and conditions, and the number of cases within each group was not sufficiently balanced, an analysis of durations measured on this word would be statistically invalid. However, since the inter-rater agreement was highly significant (reported in Section 3.2.3.2), and a consistent lengthening effect was found for the first lexical word, there seems to be no reason to doubt the phoneticians’ judgements.

The perceptual judgements of the location of the accents were analysed for the types of phrases distinguished by the judges. The results are given in Table 3. The table shows that the majority of realisations supports the claim that Clash Resolution is obligatory within the Phonological Phrase, and blocked by a Phonological Phrase boundary (cf. the numbers in the shaded cells).

Table 3: The location of the accent in the first lexical word in the items in Condition 2 divided on the basis of phonological phrase structure, as judged by three French phoneticians (\(\sigma\sigma\) word-initial accent, \(\sigma\sigma\) or \(\sigma\sigma\): word-final accent, \(\sigma\sigma\) or \(\sigma\sigma\): the syllables have equal prominence; \(X\): the judges disagreed).

<table>
<thead>
<tr>
<th>Phonological Phrase structure</th>
<th>Perceptual prominence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>(\sigma\sigma)</td>
</tr>
<tr>
<td>Non-restructured</td>
<td>7</td>
</tr>
<tr>
<td>Restructured Type 1</td>
<td>20</td>
</tr>
<tr>
<td>Restructured Type 2</td>
<td>8</td>
</tr>
<tr>
<td>(X)</td>
<td>0</td>
</tr>
</tbody>
</table>

\textsuperscript{35} As mentioned in Section 3.2.3.2., the judges did not agree on the location of the strongest juncture in four cases.
In the non-restructured cases (first row), the judges indicated that Clash Resolution had applied in only seven out of 101 cases, and in six out of the 56 of the restructured cases (second and third rows), Clash Resolution had not applied. Thus, a total of 13 out of 161 cases in Condition 2, or 8%, contradict the claim that Clash Resolution is bounded by the Phonological Phrase. These results strongly suggest that branching complements may indeed be restructured and that when they do, Clash Resolution takes place. However, in view of the unexpectedly large number of cases in which the judges indicated that the syllables were equally prominent (third column: 40 cases; only 10 and 21 cases in Conditions 1 and 3 respectively), an analysis of the fundamental frequency traces was performed to see to what extent the pitch pattern reflected the perceptual judgements.36

3.5.3.2. Clash Resolution and fundamental frequency
In order to determine whether for each individual case, the syllable that was judged to be the most prominent actually coincided with the highest pitch peak, the perceptual and acoustic data in the three conditions were compared. Table 4 cross-tabulates the perceptual and acoustic data. The fourteen cases in which the judges disagreed on the location of the accent have not been included. From top to bottom, the rows give the counts for the judgements ("1": word-initial prominence, "2": word-final prominence, "=": equal prominence), which are subdivided from right to left on the basis of the relative height of the pitch peaks at points 2 and 3 ("1": peak is highest at point 2, "2": peak is highest at point 3, "=": peaks are the same at points 2 and 3). The numbers in the shaded cells represent the cases in which the judgements did not agree with the fundamental frequency measurements; agreement cases are given in the cells along the diagonal.

Table 4: The perceptual and acoustic data in the three phrasing conditions ("1": point 2 > point 3, "2": point 3 > point 2, "=": point 2 = point 3).

<table>
<thead>
<tr>
<th>Measurements</th>
<th>1</th>
<th>2</th>
<th>=</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judgements</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>260</td>
<td>15</td>
<td>1</td>
<td>276</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>103</td>
<td>7</td>
<td>124</td>
</tr>
<tr>
<td>=</td>
<td>14</td>
<td>13</td>
<td>44</td>
<td>71</td>
</tr>
<tr>
<td>Total</td>
<td>288</td>
<td>131</td>
<td>52</td>
<td>471</td>
</tr>
</tbody>
</table>

As can be seen in Table 4, the number of agreement cases (407) by far exceeds the number of disagreement cases (64). In 363 cases, the judges perceived an accent on a syllable with a pitch peak, or indicated equal prominence when the fundamental frequency measurements indicated the same (44 cases). A statistical analysis was performed to establish whether this proportion of agreement was indeed larger than the expected agreement at chance level. The results of this analysis were highly significant (Kappa =

36 The 'equal prominence' cases cannot provide evidence for or against the Phonological Phrase boundedness of Clash Resolution, because it is not clear what their accentual pattern is.
0.7538, \( \text{ASE} = 21.517, p<0.001 \).\(^{37}\) This finding was repeated when judgements and measurements were compared for each condition separately (Condition 1: Kappa = 0.7036, \( \text{ASE} = 11.164, p<0.001 \); Condition 2: Kappa = 0.6565, \( \text{ASE} = 11.292, p<0.001 \); Condition 3: Kappa = 0.7175, \( \text{ASE} = 11.670, p<0.001 \)), which further confirms that the judgements were indeed reflected in the pitch trace.

However, Table 4 also shows that in 44 cases, judgements and measurements agreed that the two syllables in the first lexical word were equally prominent. This finding suggests that Clash Resolution is not necessarily characterised by the presence of a word-initial pitch accent. We decided to compare the cases with equal, initial and final prominence (as indicated by the judges) in order to establish at which points their respective pitch patterns were actually different. The mean fundamental frequency values of the three groups is represented in Figure 7. As before, the fourteen cases in which the judges disagreed on the location of the accent were excluded from the analysis.

Figure 7: Mean fundamental frequency values measured at the five points. Graphs represent data in which (1) Clash resolution has applied, (2) Clash Resolution has not applied, (3) the syllables are equally prominent, as indicated by judgements. The scores were pooled over items, subjects and conditions (total number of observations represented = 2355).

Figure 7 clearly shows that, as expected, the location of the highest peak in the first lexical word (cf. points 2 and 3) is related to the judgements of Clash Resolution. However, mean values in the word-initial syllable (point 2) fail to distinguish between cases with and without Clash Resolution, whereas equal prominence cases can only be distinguished from Clash Resolution cases in that they do not have a higher pitch peak at point 2. An analysis

\(^{37}\) The value of Kappa is reported here, because it specifically tests the probabilities related to the values in the diagonal of the matrix (Pearson’s chi-square = 506.35, \( p<0.001 \)).
of variance (SPSS Manova) with the factors CLASH RESOLUTION (3 levels) and POINT (5 levels) was performed to statistically verify these observations. We found a significant interaction between the factors (CLASH RESOLUTION x POINT: $F_{1,8}=2.91, p<0.01$), which confirmed that the effect of Clash Resolution was not significant for all points.\footnote{Significant main effects: CLASH RESOLUTION $F_{1,3}=4.18, p<0.05$, POINT $F_{1,8}=45.05, p<0.001$.} We decided to explore the significance levels of CLASH RESOLUTION by the levels of POINT (post-hoc Tukey's HSD, significant at the 5% level) in order to establish at which points fundamental frequency differed significantly as a function of Clash Resolution. The analyses showed that only fundamental frequency values at point 3 were significantly different for cases with and without Clash Resolution ($F_{1,3}=5.49, p<0.05$). In other words, Clash Resolution is signalled by the absence of a word-final pitch peak on the first lexical word, while the simultaneous realisation of a word-initial pitch accent would appear to be optional.

### 3.5.4. Conclusion

The comparison of the perceptual and acoustic data reported in this section showed that, although the judges were found to consistently identify the syllable with the highest pitch peak as the accented syllable, Clash Resolution was not always realised with a two-accent pattern. In 44 cases, judgements and measurements agreed that there was no pitch accent on the first lexical word. Nevertheless, all cases without Clash Resolution were realised with a significantly higher pitch peak on the word-final syllable. This means that we have to reject our third hypothesis, according to which the application of Clash Resolution as indicated by perceptual judgements should be reflected in the realisation of a word-initial as opposed to a word-final pitch peak. Instead, we have to conclude that Clash Resolution is characterised by the absence of a word-final pitch accent on the first lexical word rather than the presence of a word-initial pitch accent on this word.

The results fully supported our fourth hypothesis that restructuring of a lexical head and its branching complement is reflected in the application of Clash Resolution. First, restructuring did in fact take place in items which consisted of a lexical head followed by a branching complement, a finding which contradicts the claims made in the literature. In 56 of the 161 cases in Condition 2 (35%), speakers regrouped the noun and the following adjective or adverb into one Phonological Phrase. In 40 of these cases, a Phonological Phrase boundary was produced after the second lexical word, and in 16 cases the speakers did not produce any boundaries within the item at all. Second, an analysis of the perceptual judgements on the accentual patterns showed that only 13 out of 161 cases contradicted the claim that Clash Resolution is sensitive to restructuring in this context. The perceptual judgements were corroborated by the acoustic analysis of the pitch trace. We can therefore conclude that the optional application of Clash Resolution provides evidence for the optional restructuring of lexical heads and their branching complements.
3.6. Discussion

The experimental investigation reported in this chapter showed that (a) Clash Resolution is bounded by the Phonological Phrase, while Liaison is not, (b) restructuring of a lexical head and its branching complement is possible, and their accentual patterns are also compatible with the Phonological Phrase boundedness of Clash Resolution, and (c) the realisation of an initial pitch accent on the stress shift item in Clash Resolution cases is optional. These findings have three important implications.

First, our results seem to be incompatible with the view that the metrical prominence of the word-final syllable of the first lexical word is shifted to the initial syllable. Rather, Clash Resolution involves the obligatory deletion of the word-final pitch accent, with the presence of an initial pitch accent being optional. In other words, our findings lend further support for the pitch-accent-based analysis that was originally proposed for English (Bolinger 1981; Gussenhoven 1987, 1991a; Shattuck-Hufnagel 1991). Verluyten (1982) accounts for one-accent patterns in French by differentiating between a rule that weakens the first strong node of two adjacent strong nodes and a rule that makes the weak node of word-initial syllables strong (both based on Schane 1979). He claims that variants of French in which such patterns are produced do not have the second rule. We would like to suggest that such variability can be adequately captured in a constraint-based account, as proposed in the following chapter.

Second, our findings imply that the variability in the application of Clash Resolution cannot be fully accounted for by means of the restructuring rules proposed by Nespor and Vogel (1982, 1986) and Verluyten (1982). The data in this experiment indicate that monosyllabic adjectives or adverbs that constitute the first word of a branching complement can also function as the head of a Phonological Phrase that includes any preceding noun. Obviously, the relation between branchingness and restructuring of Phonological Phrases needs to be reconsidered. It should be noted that the restructured Phonological Phrase is very similar to Selkirk’s Maximal Phonological Phrase (Selkirk 1974, 1986, 1995), which allows regrouping of lexical heads and their direct complements. Selkirk, assuming the X-bar theory of phrase structure (Jackendoff 1977), distinguishes between two levels of morpho-syntactic structure that are relevant to Phonological Phrase formation: the maximal projection of a lexical word (N, V, or A), designated by Xmax (the Maximal Phonological Phrase), and intermediary projections, designated by X’ (the Small Phonological Phrase). Unlike Verluyten (1982) and Nespor and Vogel (1982, 1986), she does not stipulate that the direct complement should not be branching. Moreover, for Maximal Phonological Phrases to be formed in French, the head of the first Phonological Phrase must be inflected. She motivates this requirement on the basis of the optional application of Liaison in French. Although we established that it is highly unlikely that Liaison is conditioned by the Phonological Phrase, which seems to invalidate the inflectedness requirement, the results of the present investigation can be interpreted to support Selkirk’s proposal for Phonological Phrase formation.

39 The fact that these cases were not consistently produced by the same speakers in the present experiment seems to suggest that the optionality of the initial accent may result from factors other than dialectal variation.
However, it is not entirely clear whether the factors that condition restructuring are adequately captured by Selkirk's rules. Her proposal cannot incorporate the finding that the number of restructured phrases in Condition 3 was much larger than those in Condition 2 (60% and 35% respectively). The different behaviour of the items in the two conditions might be related to their different lengths in terms of number of syllables. Previous research has shown that speakers tend to produce utterances that consist of Phonological Phrases of roughly the same length (Wenk and Violand 1982; Pasdeloup 1992b; Vaissière 1992; Delais 1995; for Italian: Helsloot 1995). This seems to suggest that, although lexical words tend to group together when they are part of the same maximal projection, the rules for Phonological Phrase formation are further constrained by a potentially conflicting length requirement. In the Optimality Theoretic account of French prosody presented in the following chapter, the relative ranking of a limited set of conflicting well-formedness constraints describes the different outputs resulting from the interaction between pitch accent assignment and phonological phrasing.

Third, the present investigation raises the question of how, if Liaison is not bounded by the Phonological Phrase, it can be accounted for in the grammar. One should bear in mind that the domain tested in this experiment was derived on the basis of syntax. In our experimental items, the boundaries of the Phonological Phrase always coincided with the edges of a lexical head. This implies that possibly, the edges at which Liaison is applied are in reality syntactic and just happen to coincide with the edges of the Phonological Phrase. Booij and de Jong (1987) found that the frequency of occurrence of a word is highly correlated with the pronunciation of the Liaison-consonant. If word frequency indeed conditions the application of Liaison, the results for the Phonological Phrase can be placed in a different light. In this case, the conflicting instances of non-application of Liaison within the Phonological Phrase may stem from the fact that only very frequent adjectives occur in pre-nominal position. Clearly, the results of the present experiment give rise to speculations about the role of word frequency and syntactic constituency in the application of Liaison. The next section will tentatively explore the direction in which an account for the application of Liaison may be found.

3.7. A tentative proposal for the conditions on the application of Liaison

The variability in the application of Liaison has been accounted for in various ways (Section 3.1.2.2). Apart from syntactic context, a number of other factors are assumed to affect Liaison, such as syntactic category, word frequency, the nature of the latent consonant and that of the preceding segment. It has also been noted that socio-cultural and style factors (formal versus informal speech) play a role in the variability between speakers (see Booij and de Jong 1987 for an overview).


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40 It should be noted that only Delais explicitly mentions the Phonological Phrase in relation to this issue. The domain Wenk and Violand, Vaissière and Pasdeloup refer to roughly corresponds to the Phonological Phrase as discussed in this chapter.
and de Jong (1990, 1994) propose the Phonological Phrase as the domain of application of Liaison. However, the results of the experiment reported here have shown that the application of Liaison cannot be predicted on the basis of Phonological Phrasing, as was implied by previous findings (e.g. Morin and Kaye 1982). Although Liaison is very frequent in the Phonological Phrase where it was taken to be obligatory, it does not always apply within this domain (also Booij and de Jong 1987, De Jong 1994). Moreover, de Jong (1994; cf. Morin and Kaye 1982) points out that Liaison has been found to apply across Phonological Phrase boundaries (although this is rare). If the Phonological Phrase cannot fully account for the variability in the application of Liaison, then what factors do condition its application? In the literature, syntactic constituency and lexical allomorphy have been proposed as factors that play a role in the application of Liaison.

### 3.7.1. Syntactic constituency

If the constraints on the application of Liaison are defined purely on prosodic grounds, Liaison should behave like a postlexical process. Three circumstances argue against a postlexical process:

I. Liaison can be applied despite pause insertion.

II. Restructuring cannot account for the optional application of Liaison.

III. Liaison requires direct reference to syntax.

Firstly, postlexical rules are sensitive to pause insertion, because pause insertion takes place postlexically (Mohanan 1982, who cites Rotenberg 1978). Thus, if the realisation of the Liaison consonant is conditioned by the Phonological Phrase, Liaison should be blocked by a pause. However, pauses have been reported to occur both before and after a Liaison consonant (Section 3.1.2.2), and several instances of a pause occurring before the Liaison consonant were found in the production experiment reported here (Section 3.3).

Secondly, if domains may restructure to form a larger domain for the application of phonological processes under the influence of the rate of speech, such processes should be sensitive to speaking rate and boundary weight (Nespor 1990:393). As restructuring provides an adequate account of the observed variability in the application of Clash Resolution, it is very likely that the restructured Phonological Phrase is a prosodic constituent in French. Therefore, if Liaison is a postlexical process, the formation of a restructured Phonological Phrase should be reflected in the application of Liaison, which is not the case. Conversely, if Liaison is syntactically conditioned, it has to be insensitive to rate of speech and sensitive to syntactic constituency. This is exactly what seems to be the case for Liaison in our experiment.

Thirdly, direct reference to syntax is required to account for Liaison in the restructured Phonological Phrase, as argued by de Jong (1994) on the basis of a study of a large corpus of spontaneous speech (the ‘Orléans corpus’). For example, Liaison is restricted to inflected nouns followed by adjectives, and never applies between inflected nouns and complements other than adjectives. The restructured Phonological Phrase wrongly predicts the surfacing of the Liaison consonant in some cases, while in
other cases, it wrongly predicts that Liaison is impossible (Booij 1986; Booij and de Jong 1987). Thus, the evidence for 'optional Liaison' suggests that syntactic constituency rather than prosodic phrasing is at stake here. The application of Liaison within the Phonological Phrase also requires direct reference to syntax. De Jong points out that differences in grammatical category appear to play an important role in the variability in the application of 'obligatory' Liaison, such as, for instance, the blocking of Liaison by a coordinator, as in (21).

\[(21) \quad \text{\{two or three children\}}\]

If Liaison is assumed to be prosodically bounded, such categorical exceptions threaten to considerably undermine the validity of the theory of Prosodic Phonology, because they imply that postlexically, Liaison needs to refer back to the syntactic component of the grammar.

In view of these arguments, we may safely conclude that Liaison is not purely prosodically conditioned.

3.7.2. Lexical allomorphy

De Jong (1994) observes that the application of Liaison is variable in some words, but impossible in others. Moreover, in words that can have Liaison, the frequency of application varies. This suggests that the application of Liaison depends on the lexical identity of a word.

Since Selkirk's and Nespor and Vogel's notions of the Phonological Phrase cannot refer to the lexical properties of words, de Jong (1994:106) tentatively suggests that the forms with the Liaison consonants have been lexicalised. This means that the lexicon has two underlying representations for each word that can have Liaison (lexical allomorphy), whereas words that cannot surface with Liaison have no underlying 'Liaison-form', i.e. have only one underlying representation, as illustrated in (22). Words like *filles* in (22a), which can surface with a Liaison consonant, would underlingly have two lexical allomorphs, whereas words like *hivers* in (22b), which was not produced with Liaison in our experiment, would not.

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41 Booij (1986) and Booij and de Jong (1987) mention the following:
- Adjective heads followed by a complement (*pot au feu* 'stew')
- Non-inflected heads followed by a complement (*le cas échéant* 'if need be').
- Past participles and infinitives
- An inflected head and a non-complement (*Ils réfléchissent -Av- avant de répondre* 'They think before they answer')

42 De Jong (1994) distinguishes between "real" function words and closed category heads (prepositions, forms of *être* and *avoir*, modals). According to his data, even "real" function words do not always surface with Liaison (between 93-99%). Moreover, he stipulates that *être, avoir* and modals show the same behaviour as verbs followed by complements outside the domain of the Phonological Phrase.

43 Since irregular forms tend to be more liable to lexicalisation when they are used frequently, it could be argued that Liaison depends on the lexicalisation of Liaison allomorphs (see de Jong 1994:124-125 for a discussion).
Accounting for the variability of Liaison by means of lexicalisation is supported by the observation that Liaison is recessive,44 a tendency frequently mentioned in the literature (cf. Booij and de Jong 1987).45 The fact that Liaison is no longer productive can be seen in phrases with loan-words, such as *gens rze* 'trendy people', which never have Liaison (see also Clements and Keyser 1983). Moreover, Liaison is obligatory in fixed expressions such as *accent aigu* ‘acute accent’ and *le cas échéant* ‘if need be’ (Delattre 1951), whereas it is rare in phrases such as *un cas amusant* ‘an amusing case’. This seems to imply that in frequent combinations of words, its use has become fossilised (Booij and de Jong 1987).

De Jong was not the first to propose lexicalisation to account for the variability of Liaison, but unlike other lexical accounts, he defines a context for the insertion of the Liaison allomorph. In his view, the Phonological Phrase conditions the surfacing of Liaison allomorphs in informal speech. Occurrences of Liaison outside this domain are stored in the lexicon in their entirety, i.e. as word combinations. Although this assumption allows him to formally distinguish between contexts in which speakers have the option to insert the Liaison allomorph for some word and contexts in which the same word cannot surface with Liaison, it has the disadvantage of requiring a two-step model of lexical insertion. That is, we need lexical insertion not only at the syntactic level, but also at the postlexical level, given that the Phonological Phrase only becomes available postlexically.

Moreover, De Jong’s proposal differs from other lexical accounts in that he assumes that in informal speech, all forms of the Liaison allomorphs are stored in the mental lexicon, instead of being derived by rule. Thus, he does not distinguish between

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44 As Hayes (1990:105) points out, typically, rules originate as phonetic realisations. They become categorical, exceptionless postlexical rules. Subsequently, they accumulate exceptions and irregularity and become lexical rules. Ultimately they disappear.

45 However, Morin and Kaye (1982) suggest that Liaison may still be productive in cases where the Liaison consonant functions as a plural marker.
cases in which the surface form of the allomorph is unpredictable (e.g. *beau-bel* ‘beautiful’) and cases in which it is (e.g. plural Liaison (as in 20) and verb Liaison). Tranel (1990:172) argues that the latter cases should be captured by general rules instead of separate lexical listings. In the following section, we will propose an analysis based on Hayes (1990), which (a) allows us to derive predictable forms of Liaison allomorphs by means of lexical phonological rules, and (b) does not require two-step lexical insertion.

### 3.7.3. Precompilation

According to Hayes’ Precompilation Theory, phonological rules fall into two classes (1990:87):

I. truly phrasal rules (apply postlexically)
II. lexical rules (apply pre-syntactically within the lexicon). A subclass of these rules is responsible for the insertion of ‘precompiled forms’.

Liaison is a precompiled rule, in Hayes’ view. Precompiled forms are allomorphs contained in the lexicon for certain classes of words. The forms of the allomorphs are automatically derived in the lexicon by lexical phonological rules. The rule for the derivation of the Liaison-allomorph could be formulated as “include the extrasyllabic element in the stem of the allomorph”, which element is predictably /z/ in the case of plural forms. Thus, the predictable form of the precompiled allomorphs can be captured for whole classes of words, a feature which distinguishes precompilation from lexical listing. By contrast, the unpredictable form of the Liaison-allomorph of pairs like *beau-bel* would not be derived by rule, but is lexically listed (analogous to the treatment of the determiner *a-an* in English, see Hayes 1990:95). This means that the distinction Tranel (1990) makes between suppletive and non-suppletive Liaison is captured by the absence of lexical phonological rules for the derivation of allomorphs whose forms are not predictable.\(^{46}\)

The appropriate allomorph is inserted in the relevant syntactic environment at the interface between syntax and phrasal phonology.\(^{47}\) According to Hayes, a speaker’s choice to insert an allomorph depends on ‘Phonological instantiation frames’. These frames, which are included in a language’s lexicon, serve as standardised contexts for the phonological instantiation of words. Thus, French words can have an extra allomorph which will appear in a particular context. The frame for Liaison (Frame 1, 1990:96)\(^{48}\) would, for instance, insert the Liaison allomorph for *petits* during the process

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\(^{46}\) It could be argued that, in view of its predictable form, plural Liaison should not be accounted for by means of lexical allomorphy, but by means of phonological rules that operate at the postlexical level. In this case, plural Liaison would have to refer back to the syntactic component of the grammar, as the surfacing of plural Liaison consonants appears to be syntactically conditioned (Section 3.7.1). A precompiled account of plural Liaison does not have this drawback (see below).

\(^{47}\) The lexical insertion process takes place in two steps (Hayes 1990:91): (a) An element is inserted into a syntactic tree of abstract place markers, indicating the identity of the word and its syntactic properties; (b) Post-syntactically, the abstract markers are phonologically instantiated with phonemic material (intervenes between the syntax and true phrasal phonology, thus ensuring that syntactic rules cannot refer to phonological content).

\(^{48}\) *Frame 1: [x\_X\_\_\_]* This frame specifies the environment where the "Liaison allomorph" of adjectives and
of phonological instantiation in the phrase *de petits enfants*. It should be noted that, since the insertion takes place at the interface between syntax and phrasal phonology, the process does not require direct reference to syntax at the postlexical level.

In the precompilation account, Liaison cannot be a postlexical process. Four characteristics of Liaison support this view. As we have seen in the previous sections, some words can surface with Liaison whereas others never can, Liaison is recessive and Liaison can be produced despite pause insertion. The fourth characteristic that supports the view that Liaison is a precompiled rule is the finding that it seems impossible to formulate an adequate prosodic definition of its domain of application.

Nevertheless, Hayes’ frame for Liaison does not fully cover the facts, since Liaison also applies after, for instance, determiners (cf. Nespor 1990). A minor adaptation of Hayes’ frame 1 would solve this. Two other contexts Hayes’ frame does not cover are inflected nouns and their complements (if adjective) and major category verbs and their complements. A provisional suggestion to account for these forms is that a second - possibly socially and educationally marked - frame marks the allomorphs of nouns and major category verbs [Frame 2]. Frame 2 will provide for the insertion of this set of allomorphs in this particular context. Consequently, at least two frames will have to be included in the lexicon.

3.7.4. Conclusion

It has become apparent that Liaison is a heavily lexically and syntactically marked process. Precompilation Theory claims that so-called ‘syntax-sensitive rules’ are in fact lexical rules. The domain of application of precompiled rules is defined by syntactic ‘frames’ rather than syntactic context, thus allowing rules like Liaison to be treated as a residue left unaccounted for by Prosodic Hierarchy theory. The advantage of assuming syntactic frames for Liaison is that they allow for a unified account of all occurrences of Liaison in the sense that no theoretical distinction needs to be made between postlexical Liaison on the one hand and purely lexically or syntactically driven Liaison on the other.

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The structural description of the lexical phonological rule that derives allomorphs for adjectives and quantifiers includes the specification for this frame. 

49 That is, the precompiled Liaison form of, for instance, *petits* in the sentence *je fais de petits achats* has been phonologically instantiated as /pətəz/ before phrasal phonological rules apply, unlike the surface forms /ʃ/ and /d/ of underlying /ʒə/ and /də/ in /ʃɛdptɪtəʃə/ which result from regressive assimilation in the phonological component of the grammar.

50 Hayes suggests that “in careful speech, French speakers make use of largely obsolete phonological instantiation frames, which are artificially preserved by education and social pressure” (1990:107).
Chapter 4  An Optimality-Theoretic account of pitch accent distribution

4.1. Introduction

The experimental findings of the previous chapter clearly confirmed the claim that the Phonological Phrase is the domain of the distribution of pitch accents in French. That is, indirect reference to X' and X'' category heads in the syntactic structure as proposed by Selkirk (1986) allows us to formalise the occurrence of pitch accents that mark the end of groups of words traditionally referred to as Sense Groups, Rhythmic Groups or Breath Groups (cf. Chapter 2 section 2.1). However, it is unclear how the interaction between phonological phrasing and pitch accent assignment is best described. The results of the experiment revealed considerable variation in Phonological Phrase formation and in the realisation of non-final pitch accents. Such effects are difficult to describe in a rule-based account, as is argued in the following subsection. An alternative analysis in Optimality Theory, which is introduced in the second part of this section, will be proposed that captures the facts more insightfully. It will be shown that the location of pitch accents can be described by the prioritisation of a limited set of universal well-formedness constraints. In Section 4.2, the accentual patterns are presented which are assumed to represent the ‘default’ realisation in unmarked contexts. These data are analysed in the Optimality-Theoretic framework in Section 4.3. Section 4.4 aims to show that prosodic variation can be handled more elegantly and insightfully in the proposed constraint-based analysis, and Section 4.5 concludes the chapter with a discussion.

4.1.1. Some issues which are problematic for a rule-based account

Accounting for French prosodic structures in a rule-based approach proves problematic in several respects. First, a rule-based account needs to distinguish between pitch patterns that result from ‘default’ pitch accent placement and pitch patterns produced in clash contexts. Thus, the realisation of C'est étonnant ‘It's surprising’ with a word-initial and a word-final pitch accent on étonnant is derived by the rules according to which the word- and phrase-final full syllables are accented, and a rule which enforces the realisation of word-initial pitch accents, whereas in C'est une jolie jupe ‘It's a pretty skirt’, the location of the accent on the first syllable of jolie derives from a different rule, i.e. Clash Resolution. A provisional formulation of the rules is given in (1), where syllables are accented when they are underlined ("\(\bar{\circ}\)").
(1) Phrase-final rule: \( \sigma \rightarrow \sigma / (\theta) \)  
Word-initial rule: \( \sigma \rightarrow \sigma / [\sigma, \sigma] \)  
Clash Resolution: \( [\sigma (\sigma^n \sigma] \rightarrow [\sigma (\sigma^n \sigma] / \sigma (\theta)] \)  
Word-final rule: \( \sigma \rightarrow \sigma / (\theta) \)

According to the ‘phrase-final rule’ in (1), all phrase-final syllables are accented, unless the syllable is a schwa, in which case the pre-final syllable is accentuated. The ‘word-initial rule’ assigns pitch accents to the initial syllable of words with more than two syllables. The Structural Description of the third rule, Clash Resolution, states that polysyllabic words have an initial instead of a final pitch accent when they are immediately followed by a phrase-final pitch accent (the variant in which only the phrase-final accent surfaces will be discussed below). The fourth accentuation rule enforces the accentuation of word-final syllables that do not coincide with a Phonological Phrase boundary, as in de très jolies jupes ‘very pretty skirts’. The derivation of the surface patterns by means of the rules in (1) is illustrated in Figure 1 (these surface forms will be discussed in Section 4.2).

The realisations in Figure 1 suggest that Clash Resolution patterns and patterns that can be observed when there is no clash context have the same surface form. Nevertheless, the two have different derivational histories in a rule-based account. Moreover, the location of the second pitch accent in phrases such as de très jolies jupes on très rather than jo does not follow straightforwardly from the derivational process. Apparently, one of the rules needs to be modified, or an additional rule has to apply in this specific context. Adapting the ‘word-initial rule’ in such a way that only the initial and final metrically strong syllables in the Phonological Phrase are realised with a pitch accent cannot remedy the situation, as it would wrongly predict all Phonological Phrases to surface with two pitch accents only, excluding realisations like de très jolies enfants. Thus, the rules need to be ordered such that all word-final strong syllables are accented, unless this entails a clash, in which case intermediate pitch accents are not realised. Moreover, an additional stipulation is required in the latter situation for the generation of phrases like une assez jolie jupe ‘a rather pretty skirt’, where the word-initial syllable in assez is skipped in favour of the word-final syllable. Alternatively, the rule of Clash Resolution could be modified such that all prosodic words are skipped in favour of the first one in the Phonological Phrase. However, this only provides a marginally less cumbersome solution, because accounting for une assez jolie jupe would still involve the same additional stipulation.

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1 The rule is assumed to refer to the prosodic word here, and only lexical words can be parsed as prosodic words (i.e. verbs, nouns, adjectives and adverbs). Alternatively, the rule could refer to the first metrically prominent syllable in the phrase (usually the first syllable of a lexical word). The rule would be motivated by the observation that Phonological Phrases are usually marked by an early and a late pitch prominence, also when Clash Resolution does not apply (Di Cristo and Hirst 1984; Mertens 1992; Pasdeloup 1992; Vaissière 1992; Delais 1994; Jun and Fougeron 1995, to appear; Di Cristo to appear; note that the authors refer to prosodic units that are similar to the Phonological Phrase).
Figure 1: Derivation of the surface prosodic patterns for C'est étonnant and C'est une jolie jupe in a rule-based approach.

A second issue, which was raised in the previous chapter, concerns the relation between restructuring and the length of phrases in terms of syllables. As we have seen, reference to X' projections in the morpho-syntactic structure instead of branchingness makes better predictions about the cases in which the (re)grouping of Phonological Phrases leads to the deletion of Phonological Phrase final pitch accents. That is, the end-based approach (Selkirk 1984, 1986) allows us to capture the strong tendency for phrases like des enfants sages to restructure (70% of cases in the experiment) and the possibility of restructuring in phrases with branching complements like des hivers autres qu'en Afrique (36% of cases). A second advantage of this approach, which has not been mentioned so far, is that it can easily capture the behaviour of non-heads when they occur in final position, such as the pronoun and the adverb given in (2a) and (2b), respectively. The presence of the pitch accent on the non-head and the simultaneous absence of the word-final pitch accent on the preceding lexical head suggest that the non-heads and the preceding heads are included in a single Phonological Phrase.

(2) a. Paul disait: “Fais-le.”
   b. Il dort peu.
   ‘Paul said: “Do it.”’
   ‘He sleeps little.’
Since function words and adverbs cannot function as the heads of a Phonological Phrase in the relation-based approach (Nespor and Vogel 1982, 1986), Verluyten (1982:128) proposes to modify the Phonological Phrase formation rule such that post-posed pronouns and monosyllabic adverbial complements group with the preceding lexical head (i.e. the verb). An additional rule stipulates that the rightmost word in the Phonological Phrase is always metrically strong. Although this allows non-heads to be accentted in this position, it entails that two phonologically different types of regrouping are involved in Phonological Phrase formation in French: (1) inclusion of post-posed non-heads and (2) restructuring, which merges Phonological Phrases formed on the basis of lexical heads. In the end-based approach, all Phonological Phrases fall out from the same principle, i.e. all material of the maximal projection is included in one and the same Phonological Phrase (Selkirk's Maximal Phonological Phrase). If the Phonological Phrase contains X’ projections, they can form a Phonological Phrase on their own (Selkirk’s Small Phonological Phrase). Thus, phrase-final non-heads are automatically included in the Phonological Phrase because they are part of the maximal projection, and they are in a position to receive the obligatory phrase-final pitch accent.2

Nevertheless, the end-based approach cannot fully account for the data either when it is couched in a rule-based framework. When Il dort peu in (2a) forms a single Phonological Phrase, mapped onto the maximal projection, Clash Resolution could be assumed to eliminate the pitch accent on dort. However, there is no a priori reason why X’ dort cannot form a Phonological Phrase on its own. In this case, the adjacent syllables could both be accentted, because a Phonological Phrase boundary intervenes between them. In order to express that this realisation is marked, an apparently arbitrary additional rule would be needed to block the formation of Small Phonological Phrases in this particular context. Second, as mentioned, it cannot straightforwardly formalise the tendency for prosodic constituents to have roughly the same length in an utterance (Vaissière 1992; Pasdeloup 1992b; Delais 1995).3 For instance, the experimental results of the previous chapter showed that the majority of the items in which X’ was followed by a single syllable within the X”

2 Elsewhere in his thesis, Verluyten presents a slightly different treatment of cases such as (2a). Referring to Selkirk (1972), he assumes that the word boundary between a verb and a post-posed clitic is suppressed, and that all suffixed clitic pronouns are metrically strong, with the (apparently arbitrary) exception of -je (e.g. puis-je ‘can I’ dois-je ‘must I’ and fais-je ‘do I’; in these cases, the schwa does not have to be pronounced). In our view, the exception does not need to be stated, because -je never occurs at the end of a Phonological Phrase. Also, the necessity of stipulating that all (but only) suffixed clitic pronouns are metrically strong, which is prompted by the absence of accents on word-final schwa’s in lexical words, is obviated in the present account by the fact that such schwa’s cannot be parsed as separate Prosodic Words (Selkirk 1995; section 4.3.1).

3 Most accounts for French in which the prosodic (metrical) structure is congruent to the syntactic structure, but which were not formulated in the framework of Prosodic Phonology, allow for modifications of the derived syntactic constituents (e.g. Dell’s principe d’eurhythmie (Dell 1984), Martin’s “index of disrythmicity” which reorganises units while taking level in syntactic structure into account (Martin 1987), and Rossi’s phonotactic module that modifies intoneme levels while taking factors such as the number of syllables into account (Rossi 1993). However, as Pasdeloup (1992) points out, they only compensate for weaknesses in the model after the derivation of the prosodic structure from syntax.
projection formed a single Phonological Phrase (70% of cases), whereas items with more than one syllable in this position tended to be realised as two Phonological Phrases, aligned with the two X' category words of the maximal projection (64% of cases). As will be shown, a constraint-based approach is better suited to handle such facts.

The third issue, which is in part related to the previous one, concerns the description of prosodic variation. In the production experiment, the formation of Phonological Phrases on the basis of lexical heads was obligatory in some contexts (e.g. de jolis airs), but optional in others (e.g. des enfants sages and des hivers autres qu’en Afrique). A second type of variation that was observed in the experiment concerned the optionality of the first pitch accent in the items, which was omitted in 9% of cases. The extent to which speakers wish to demarcate (conceptual) units in their speech by means of phrasing and accentuation depends on factors such as speaking style, age, personal preferences and speaking rate (Coustenoble and Armstrong 1934; Grammont 1966; Delattre 1966b; Wenk and Wioland 1982; Vaissière 1974, 1983, 1992; Pasdeloup 1990a, 1992; Fougeron and Jun 1998). In a rule-based account, a set of hard-and-fast rules, which describe categorical (obligatory) prosodic phenomena, would have to be combined with a set of variable rules, which specify contexts in which very similar prosodic patterns are created optionally. The disadvantage is that the relation between the rules is arbitrary; the grammar cannot express how the interaction between the various factors determines prosodic realisations, and therefore, it cannot explain why variation occurs where it does, nor when one variant is preferred over another (cf. Anttila 1997).

The aim of this chapter is to show that the interaction between phonological phrasing and pitch accent assignment can be accounted for more insightfully in a constraint-based approach. In the following subsection, Optimality Theory is introduced, followed by an outline of the description of variation in this framework.

4.1.2. Optimality Theory

Prince and Smolensky (1993) have redefined the way in which representational well-formedness conditions determine the assignment of grammatical structure to linguistic objects. In the rule-based approach, these constraints are expressed as parameters that govern the way in which rules transform an underlying structure into a grammatically correct surface structure. In Optimality Theory (Prince and Smolensky 1993), the relation between a given input form and its matching output form is determined by well-formedness constraints on output forms. More specifically, all possible output forms that can be associated with an input form (generated by the function Gen) are evaluated against universal well-formedness constraints (by the function H-Eval) in order to determine which candidate is the optimal output form. The selection of the optimal form crucially depends on the interaction between the conflicting constraints. Constraints may be violated depending on the relative importance of the other constraints. The importance of such violations is reflected by the relative ranking of the constraints in a strict
dominance hierarchy, which may vary from language to language. The output candidate that best satisfies the constraints is selected as the optimal form. The following examples, taken from Prince and Smolensky (1993:43-44) illustrate how extrametricality effects in Latin can be accounted for in Optimality Theory. In Latin, content words never have final stress, unless they are monosyllabic. The assumption is that word-final syllables are excluded from prosodic structure, as shown in (3a).

(3) a. cér<pus> *corpús  
b. méns *<mens>

To explain why the word-final syllable in (3b) is not extrametrical, a rule-based theory will have to stipulate an exception for monosyllables. In an Optimality account, the extrametricality effect directly ensues from the interaction between two constraints. The dominant constraint involved belongs to a group of constraints that establish the relation between morphological and phonological categories. In this case, the morphology-phonology interface constraint $Lx \approx PR\ (MCAT)$ requires that any lexical word correspond to a Prosodic Word. It conflicts with the constraint NONFINALITY which requires that the head foot of the Prosodic Word is not final. The effect of the relative ranking of these constraints is shown in Tableau 1.

<table>
<thead>
<tr>
<th>Candidates</th>
<th>$Lx \approx PR$</th>
<th>NONFINALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [(méns)r]$_{PrWd}$</td>
<td>*</td>
<td>!</td>
</tr>
<tr>
<td>b. &lt;méns&gt;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In Tableau 1, the constraints are arranged in domination order. A blank cell indicates that the candidate satisfies a constraint; the stars indicate violations. If a violation is 'fatal' (the candidate no longer competes with other candidates) an exclamation mark follows the star and the following cells of lower ranked constraints are shaded. Tableau 1 shows that output candidate (a) is selected as the optimal form for mens (indicated by the pointing finger). Since $Lx \approx PR\ (MCAT)$ outranks NONFINALITY, it induces a necessary violation of NONFINALITY in this case. Even though optimal candidates violate constraints, the language-specific prioritisation of the constraints ensures that only candidates that violate lower-ranked constraints can be selected as optimal forms. Thus, Optimality Theory shifts the explanatory burden from phonological rules that rewrite underlying forms to well-formedness constraints that are used to evaluate output forms.

This means that our description of French pitch accent distribution needs to define the interaction of a number of well-formedness constraints that capture (a) the parsing of morpho-syntactic structure into prosodic structure, and (b) the assignment of pitch accents to the prosodic structure. In addition, the interaction between the constraints has to allow for the description of variation in prosodic output forms.

Clearly, a strict dominance hierarchy implies that a single output candidate will always be selected as the optimal form. Therefore, a totally ranked constraint
hierarchy excludes language variation. The solution to this problem resides in allowing the grammar to be partly unranked (Kiparsky 1993; Reynolds 1994 (both cited in Anttila 1997); Anttila 1997). That is, not all constraints are totally ranked relative to each other in the grammar, which is indicated by the dotted line in Tableau 2.

<table>
<thead>
<tr>
<th>Tableau 2</th>
<th>&lt;input&gt;</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>candidate 1</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>candidate 2</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>candidate 3</td>
<td></td>
<td>![</td>
<td></td>
</tr>
</tbody>
</table>

In Tableau 2, candidates 1 and 2, which are both acceptable variants of a form in this particular language, surface as the optimal candidate, because they only violate the constraints that are unranked relative to each other (B and C). Candidate 3, however, violates a higher-ranked constraint and is therefore eliminated. Thus, partial ranking creates multiple outputs in this language, and variation can be accounted for. Following Anttila (1997), we assume that partial ranking is specified in the grammar itself, as is shown in (4), where the square brackets mark the set of constraints which are unranked relative to each other.

(4) Grammar: Constraints: A, B, C.
Rankings: A >> B, A >> C
Constraint hierarchy: A >> [B, C]

In fact, the evaluations performed by the grammar in (4) could also be made visible by means of two tableaux instead of the one given as Tableau 2, where the two possible rankings are given separately. Thus, in one tableau, candidate 1 would be the winner, and in the other candidate 2. The grammar in (4) permits both rankings, and therefore, both candidates can surface as the optimal form.

Non-ranking is actually a fundamental characteristic of Optimality-Theoretic grammars. That is, there will always be some universal well-formedness constraints for which the relative ranking is irrelevant to the selection of the optimal output forms in a particular language. In such cases, the ranking of two or more constraints cannot be established on the basis of competing output forms, which is indicated by the dotted lines and the absence of grey shading in the unranked constraints in Tableau 3. In the tableau, constraints A to C will have to outrank D and F in order to predict that candidate 1 is the optimal candidate. Also, the violation of F is fatal unless it is dominated by E. This is not the case for constraints A, B, and C which are ranked at the top of the hierarchy. As any output form that violates one of them will be rejected, they are all inviolable. Consequently, their relative ranking cannot be established.
Tableau 3

<table>
<thead>
<tr>
<th>&lt;input&gt;</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>candidate 1</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>candidate 2</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>candidate 3</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>candidate 4</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>candidate 5</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Similar situations can arise with lower-ranked constraints. This type of non-ranking is said to be non-crucial, because the optimal candidate will be selected regardless of the dominance relations holding between the unranked constraints (Prince and Smolensky 1993).

As Anttila points out, this type of non-ranking is different from that of Tableau 2, where it leads to the selection of more than one optimal form. There, non-ranking is said to be crucial, as only the explicit absence of ordering automatically results in language variation (Anttila 1997:48). He suggests that variation enters the adult language when speakers fail to complete the task of setting the relative ranking of all constraints. The assumption is that in language learning, constraints acquire their position in the hierarchy step by step, on the basis of the evidence available to the learner (Tesar and Smolensky 1995). If so, it is only natural that partially ranked grammars should arise, Anttila argues, as partially ranked grammars are in fact less complex than totally ranked grammars, which involve more learning. In this view, the emergence or persistence of language variation over time can be explained by the rejection of unnecessarily complex grammars; introducing or maintaining rankings that do not affect categorical distinctions is uneconomical (Anttila 1997:63).

An important advantage of this approach is that variation is directly expressed in the grammar itself. There is one single grammar that allows for the generation of several optimal output forms in cases of gradient variation, while it blocks the selection of categorically non-optimal forms (cf. Kager to appear). The alternative view that variation is the result of competing grammars (e.g. Kiparsky 1993 cited in Anttila 1997) has the drawback that variation within a language cannot be formally distinguished from variation between different languages. For instance, languages vary in their rhythm types (e.g. iambic or trochaic), but this type of variation is never found within one language. Thus, if a language has two different grammars, they should somehow be more closely related than a third grammar which describes a different language, and it is unclear how this should be expressed. Also, the variation that is predicted to occur within a particular language cannot be theoretically restricted in an account with multiple grammars. Assuming that languages have a single partially unranked grammar does not have this drawback, as it will have to be captured by minimal rerankings in the constraint hierarchy. For instance, given the

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4 Here, the grammar (and hence, the output form) which emerges may be chosen on the basis of contextual factors such as speaking style, personal preferences, etc. Whether a single or multiple grammars are involved depends on the definition of a grammar (totally ranked or partially ranked; Anttila 1997:48).
constraints A, B, and C for which the ranking A >> B >> C produces the acceptable variant 1, a reranking as C >> A >> B is impossible, and the output form that would be selected by this ranking has to be unacceptable in the language.\(^5\) This approach will be shown to be successful in the description of prosodic variation in French.

For this purpose, relevant surface forms which can be assumed to represent the most usual realisation of the prosodic structure in terms of phrasing and accentuation are described in the following section. These data will be analysed in Section 4.3, resulting in what will be referred to as the 'default' dominance hierarchy. In Section 4.4, partial rankings will be discussed which capture all observed variation by means of minimal rerankings with respect to the 'default' constraint hierarchy.

4.2. The data: 'default' accentual patterns

The distribution of pitch accents is conditioned by the Phonological Phrase in French. As can be seen in (5), the Phonological Phrase is initially derived on the basis of syntax.

(5)\[\begin{array}{c}
\text{Syntactic structure} \\
\text{Phonological Phrase structure}
\end{array}\]

\text{\[\text{Ces petits enfants intelligents apprennent à parler le français.}\]}

'These small intelligent children learn to speak French'

Only lexical heads (X' or X'') can function as the heads of Phonological Phrases. Thus, the right edge of each Phonological Phrase in (5) coincides with the right edge of a lexical head (Noun, Verb or Adjective). However, French pre-nominal adjectives, such as petits, cannot function as the heads of Phonological Phrases, and

\(^5\) Another advantage, explored by Anttila (1997) for Finnish, is that it may capture frequency effects (i.e. the general preference for some variants over others).
therefore do not form Phonological Phrases on their own (Nespor and Vogel 1982, 1986; Verluyten 1982; Selkirk 1986).6

The distribution of pitch accents is given by the rule that only the pitch accent at the right edge of the of Phonological Phrase is obligatory, whereas other pitch accents are optional, as long as they do not occur on immediately adjacent syllables within a Phonological Phrase. All pitch accents are associated with strong positions in the metrical grid: (a) the word-final full syllables of lexical words ('primary accent'), and (b) the first or second syllable of polysyllabic lexical words ('secondary accent').7 When applied to the example given in (5), the distribution rule results in the pattern in (6), where the brackets indicate Phonological Phrase boundaries, and "*' stands for a pitch accent associated with a metrically strong position (the bigger stars indicate the obligatory phrase-final accents).

(6) *(Ces petits enfants) (intelligents) (apprennent) (à parler) (le français)

The distribution in (6) represents the 'default' realisation in careful speech produced at a normal rate, where accents are realised every two or three syllables (Verluyten 1982; Wenk and Wioland 1982; Pasdeloup 1990a, 1992; Delais 1995). That is, the Phonological Phrase is marked by a final accent, and additional non-final accents occur at the locations indicated.

The example in (6) also shows that a number of additional stipulations are required in order to account for the data. Firstly, according to Delais (1995:213), word-final accents take precedence over word-initial accents, as in petits which has a word-final rather than a word-initial accent (unless this leads to a clash, as in une petite jupe 'a small skirt'). This assumption seems to conflict with accounts in which the first accent is always realised as early as possible, that is, on the first syllable of the first lexical word (Vaissière 1983, 1992; Jun and Fougeron 1995, to appear). Here, the first lexical word in a sequence of two (or more) lexical words does not have to have a final accent. Although realisations in which the word-final pitch accent is lost in favour of an initial accent, even when it is not motivated by the avoidance of a clash, are certainly acceptable in French (Fónagy and Fónagy 1976; Di Cristo and Hirst 1984; Mertens 1992; Pasdeloup 1992b; Vaissière 1992; Delais 1994; Di Cristo to appear), they are treated as variants here (analysed in Section 4.4). Nevertheless, there is a strong tendency for phrases to be marked by initial pitch prominences, resulting in a hammock shape of the pitch contour.8 That is,

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6 The representation of the syntactic structure in (5) is simplified, but this does not affect the mapping between the morpho-syntactic and the prosodic structure discussed here.

As the present study is concerned with the distribution, and not the function of French pitch accents, the distinction that is usually made between the 'emphatic' and the 'rhythmic' initial accent will not be discussed here (see Dahan and Bernard (1996), Di Cristo and Hirst (1997) and Di Cristo (to appear) for an overview). The assumption that pitch movements associated with word-initial metrically strong positions should be analysed as pitch accents is defended in Chapter 3 section 3.3 and Chapter 6 section 6.4.

8 The phenomenon has been described as an "accentual arc" or "accentual bridge" (e.g. Fónagy and Fónagy 1976; Di Cristo and Hirst 1997). Pasdeloup (1992) reports that the tendency for a pitch accent to
when there is enough room for it to be realised, a secondary accent will surface as early as possible in the phrase. This is apparent when the lexical word has more than two syllables, as in (7a) and (7b), or when the phrase contains a series of monosyllabic words such that clashes would be produced if all words are accented, as in (7c) (latter examples from Hirst and Di Cristo 1984).

(7) a. C'est étonnant C'est décourageant ‘It’s surprising’ ‘It’s discouraging’
   *  *  *  *
   b. une jolie jupe ‘A pretty skirt’
   *  *
   c. un bon vin blanc  un bon vin blanc Corse
   *  *  *  *  *
   ‘A good (Corsican) white wine’

In (7a), the initial syllable of the lexical word is accented rather than the second. The ‘default’ realisation of Clash Resolution cases is given in (7b), which was observed to be the most frequent pattern in the experiment reported in Chapter 3. Following Di Cristo and Hirst (1984), we assume that in an unmarked realisation, the edges of the group also take precedence over other potential locations when the intervening syllables belong to separate lexical words. In other words, we assume that non-phrase-final pitch accents are realised on the final full syllable of every lexical word (‘primary accent’), unless this results in a clash (une jolie jupe and un bon vin blanc). Additional accents are realised on the first syllable of polysyllabic lexical words (‘secondary accent’), as long as clashes with the word-final accents are avoided.

However, the pattern given for intelligents in (6) shows that there is an exception to this rule. Here, the secondary accent is realised on the second instead of the first syllable of a word with more than three syllables (Fouché and Dauzat 1935; Séguinot 1977; Léon and Martin 1980; Dell 1984; Mertens 1992; Pasdeloup 1992b; Delais 1995). Although an approach in which metrical prominence is described in terms of an alternating pattern from the right would account for this tendency (Verluyten 1982; Tranel 1986b), we do not adopt this view, because of the finding that in vowel-initial words, the secondary accent is usually realised on the second syllable, as in (8a) (Mertens 1992; Pasdeloup 1992b). In the consonant-initial words in (8b), by contrast, the accent appears to be invariably located on the first syllable.

be realised on the first syllable of the first lexical word is particularly strong in sentence-initial position (“sentence first stress rule”).

9 According to Séguinot (1977:34), words with a prefix can also have the accent on the second instead of the first syllable of the word. However, as all of his examples have more than three syllables and start with a vowel (e.g. impardonnable "unforgivable"), it is unclear whether it is prefixation that is the determining factor in these cases. In our French informant’s pronunciation of words with the prefix pre- (préémonition, prédécoûte), the accent was always realised on the first syllable. Séguinot also claims that adverbs derived from adjectives always have an initial accent when they contain more than three syllables (1977:35). As a consequence, his predictions for a word like agréablement ‘pleasantly’ conflict with Mertens’ and Pasdeloup’s claim.
Thus, different 'default' realisations are predicted here for vowel-initial and consonant-initial words with more than three syllables.¹⁰

A third stipulation that needs to be made is that not all X' lexical heads necessarily form a Phonological Phrase on their own. The experiment reported in the previous chapter showed that sequences of Phonological Phrases in which a noun is followed by a monosyllabic adjective are usually restructured into a single Phonological Phrase (73% of cases), as in (9a), whereas the majority of cases where the noun was followed by a longer complement are not restructured (63% of cases), as shown in (9b).

(9) a. (des enfants sages)PP
b. (des hivers)PP (autres qu’en Afrique)PP

Finally, although function words are not normally accented, they are when they occur in phrase-final position, as is shown in (10) (cf. Verluyten 1982).¹¹

(10) Il disait: “Prends-le”  ‘He said: “Take it”’

Function words are defined here as determiners and modifiers (e.g. articles, auxiliary verbs, pronouns, prepositions), that is, all words that do not belong to the four major categories of nouns, verbs, adjectives and adverbs.

The distribution of pitch accents in the ‘default’ pronunciation assumed here can be summarised as follows:
I. Phonological Phrases are always marked by a final pitch accent, as in (11).
II. Additional word-initial and word-final pitch accents are realised on lexical words as long as they do not create a clash within the Phonological Phrase (12a), where:

¹⁰ The examples show that the underlying structure of the syllable must be involved in this phenomenon, and not its surface realisation (i.e. the /i/ is syllabified with the following vowel in l'impossibilité). Pasdeloup (1992) and Delais (1995) also found that secondary accents can be realised before the boundary of the morpheme in polymorphemic words, such as C'est méloDramatique ‘It's melodramatic’, or on the antepenultimate syllable in words with more than four syllables, such as des désinTOxiqués ‘former drug addicts’ (examples from Pasdeloup 1992).

¹¹ Non-final function words can be accented when they are contrasted with one another at a metalinguistic level, as in Dupont n’est pas UN chef, c’est LE chef ‘Dupont is not A boss, he’s THE boss’ (Adjemian 1978:107), and in Je n’ai pas dit ELLE va partir mais IL va partir ‘I didn’t say SHE will leave but HE will leave’ (Léon and Martin 1980:179). The description of such cases falls outside the scope of the present analysis.
- word-final pitch accents take precedence over word-initial pitch accents (12b), and
- phrase-initial accents take precedence over phrase-internal ones (12c).

III. secondary accents occur on the first syllable lexical words with more than three syllables, unless the word starts with a vowel, as in (13).

(11) a. (des enfants sages)PP b. (Il disait:)PP (Prends-le)PP
    *[ ] [ ] [ ]

(12) a. (une jolie jupe)PP b. (de petits enfants)PP c. (une assez jolie jupe)PP
    *[ ] [ ] [ ]

(13) a. (la nécessité)PP b. (l'impossibilité)PP
    *[ ] [ ] [ ]

In the following section, a constraint-based account is presented which captures these generalisations.

4.3. The ‘default’ dominance hierarchy

In the following subsections, the constraints that are involved in the realisation of word-final pitch accents will be presented first, followed by the constraints that regulate the occurrence of word-initial pitch accents. The account is summarised in Section 4.3.3.

4.3.1. Primacy of the right edge

McCarthy and Prince’s theory of Generalised Alignment provides an integrated account of alignment phenomena by incorporating reference to the edges of constituents in the relevant constraints (McCarthy and Prince 1993). Alignment constraints require that an edge of a prosodic or morpho-syntactic constituent coincides with the edge of another prosodic or morpho-syntactic constituent. Reference to a number of Alignment constraints is required to account for the location of pitch accents in French.

As is the case in Latin, lexical words need to be parsed into prosodic structure in order to be accented in French. The constraint given in (14) will ensure that every lexical word is mapped as a prosodic word, and that their edges coincide (Selkirk 1995; this constraint is analogous to the constraint Lx ≈ PR (MCAT) presented above).\(^\text{12}\)

(14) \text{WDCON:} \quad \text{Align (Lex, R/L; PWd, R/L)}

\(^{12}\)According to \text{WDCON}, every lexical word must be aligned with a Prosodic Word at their right and left edges. Like all alignment constraints, it has a counterpart \text{PWdCON}, which ensures that every Prosodic Word is also aligned with a lexical word: Align (PWd, R/L; Lex, R/L). The latter constraint is not relevant at this point (cf. footnote 20).
Since pitch accents can be assigned to the last syllable of a word, an additional constraint is needed that stipulates that prosodic words have word-final accents, given in (15) (cf. HEADωDelais 1995).

(15) **RIGHTMOSTPWD:** Align (PWD, R; Pitch Accent, R)

According to (15), the right edge of every prosodic word must be aligned with the right edge of a pitch accent (be it L*, H* or, for instance, H*L). However, as we have seen, clashes between accents are not allowed within the Phonological Phrase in French. This means that a highly ranked constraint eliminates output candidates with two consecutive accents. The relevant constraint is given in (16) (cf. Delais 1995).

(16) **NoCLASH:** two immediately adjacent accented syllables are not permitted

The evaluation of the output candidates form for *de jolis airs* and *de jolis enfants* yields the optimal output forms when WdCON and NoCLASH dominate RIGHTMOSTPWD. The constraint interaction is illustrated in Tableau 4 (RtPWD stands for RIGHTMOSTPWD; accented syllables are underlined and round brackets indicate Prosodic Word boundaries). The evidence does not allow us to establish the relative ranking of NoClash and WdCON, which is indicated by the dotted line and the absence of grey shading in the unranked constraints.

<table>
<thead>
<tr>
<th>Tableau 4</th>
<th>Ide jolis airsl</th>
<th>WdCon</th>
<th>*Clash</th>
<th>RtPWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. de (jolis) (airs)</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. de (jolis) (airs)</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c. de jolis (airs)</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. de (jolis) airs</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Ide jolis enfantsl</th>
<th>WdCon</th>
<th>*Clash</th>
<th>RtPWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [de (jolis) (enfants)]</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>b. [de (jolis) (enfants)]</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c. [de (jolis) (enfants)]</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
</tbody>
</table>

As shown in Tableau 4, the highly ranked constraints NoCLASH and WdCON force a violation of RIGHTMOSTPWD in the optimal candidate (a) for *de jolis airs*. For a violation of NoCLASH to be fatal (b), it will have to be assumed that NoCLASH

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13 Pierrehumbert (1993) proposes to modify the constraint such that the head of the pitch accent (i.e. the starred tone) aligns with the head of the prosodic constituent, arguing that heads function as locations rather than as prosodic categories. As the result would be the same in our account, the modification is not adopted here. Our analysis of the pitch accent categories that are available in French is given in Chapter 6.
outranks RIGHTMOSTPWD. WDCON also has to be assumed to be ranked over RIGHTMOSTPWD, because speakers were found to prefer two-accent patterns in phrases such as de jolis airs. Consequently, leaving a lexical word unparsed, as in (c) and (d), which would avoid a fatal violation of NOCLASH, leads to a fatal violation of WDCON. As opposed to candidates (b) and (c) for de jolies enfants, candidate (a) does not incur any violations, and it is therefore predicted to surface as the output form. Thus, the dominance relation given in (17) has been established.

(17) WDCON, NOCLASH >> RIGHTMOSTPWD

However, the interplay between the constraints given so far wrongly allows two alternative candidates for both examples, which we give in (18).

(18) a. *de (jolis)_{pwd} (airs)_{pwd}  *de (jolis)_{pwd} (enfants)_{pwd}
b. *de (jolis)_{pwd} (airs)_{pwd}  *de (jolis)_{pwd} (enfants)_{pwd}

In (18), all lexical words are parsed into prosodic words, avoiding a violation of WDCON, and not all of them are accented, which avoids a violation of NOCLASH in the case of de jolis airs. Hence, all candidates only violate RIGHTMOSTPWD. As a consequence, they cannot be distinguished from the optimal candidates in Tableau 4. The unacceptability of the candidates given in (18) suggest that there are some other well-formedness constraints at play which enforce the realisation of Phonological Phrase final pitch accents and secondary pitch accents. The following will first discuss the constraints that account for the relevance of Phonological Phrasing to the location of pitch accents. The unacceptability of the candidates in (18b) in the 'default' realisation will be dealt with in Section 4.3.2. (the variant in which (18b) is acceptable is analysed in Section 4.4 on prosodic variation).¹⁴

The experimental results reported in the previous chapter have confirmed that X' category heads usually function as the heads of Phonological Phrases and have a word-final pitch accent. The constraint ALIGNX', given in (19), stipulates that all X' need to be mapped into prosodic structure, such that their right boundaries coincide with a Phonological Phrase boundary (i.e. Selkirk’s Small Phonological Phrase).¹⁵

(19) ALIGNX': Align (X', R; PP, R)

¹⁴ As will be shown, this issue can be resolved without reference to headedness in the foot structure. That is, an alternative solution would be to reject the candidates in (18) on the ground that some of the Prosodic Words have no accent. However, utterances such as C'est une grande jupe 'It's a big skirt', in which grande cannot be accented as well as jupe in the ‘default’ pronunciation, pose a potential problem for this alternative account.

¹⁵ ALIGNX' is similar to Delais’s RYTHM, except that RYTHM only stipulates that each Rhythmic Group has to be aligned with an X' category head, and not vice versa (Delais 1995). The relative ranking of what are strictly speaking two separate constraints (i.e. AlignX': Any X' projection is a PP, and AlignPP: Any PP is an X' projection) may crucially distinguish between output candidates in other languages, but in French, the distinction does not seem to play a role in the grammar, and the constraints are therefore collapsed.
The constraint \textsc{RighTMostPP} ensures that pitch accents that are located at the right edges of Phonological Phrases are realised in the output form (cf. METRICAL\textsc{HeadGR} Delais 1995).

(20) \textsc{RighTMostPP}: Align (PP, R; Pitch Accent, R)

Several output candidates with different prosodic structures can be given for \textit{de jolîs airs}, as shown in Tableau 5. The square brackets indicate Phonological Phrase boundaries; the round brackets are omitted in the following tableaux (undominated \textsc{WdCon} would eliminate all candidates in which lexical words are left unparsed).

| Tableau 5 |
|-----------------|--------|--------|
| \textit{de jolîs airs} | RtPP | \textsc{Aix'} | Rt\textsc{PwD} |
| \textbf{a. [de jolîs airs]} | - | - | * |
| b. [de jolîs airs ...] | *! | - | - |
| c. [de jolîs] [airs ...] | *!* | - | - |
| d. [de jolîs airs] | *! | - | - |

In Tableau 5, candidate (a) is selected as the optimal form, because it violates neither \textsc{RighTMostPP} nor \textsc{AlignX’}. Candidate (b) violates \textsc{AlignX’}, because \textit{X’} category \textit{airs} is not aligned with a Phonological Phrase boundary, and the simultaneous presence of a Phonological Phrase boundary after the non-head \textit{jolîs} in (c) results in an additional violation of \textsc{AlignX’}. In candidate (d), the alignment constraint is satisfied, but because there is no phrase-final accent, it violates \textsc{RighTMostPP}. This means that the constraint hierarchy can now be specified as in (21).

(21) \textsc{RighTMostPP, AlignX’, WdCon, NoClash} >> \textsc{RighTMostPwD}

The evaluation of the output forms presented so far does not allow us to establish the relative ranking of \textsc{RighTMostPP, AlignX’}, \textsc{WdCon} and \textsc{NoClash}. For this purpose, we will now turn to the evidence provided by restructuring.

As the comparison between the output candidates in Tableau 6 shows, \textsc{RighTMostPP} and \textsc{NoClash} would have to dominate \textsc{AlignX’} in order to eliminate output candidates (b) to (e) for \textit{des enfants sages}.

| Tableau 6 |
|-----------------|--------|--------|
| \textit{des enfants sages} | RtPP | *\textsc{Clash} | \textsc{Aix'} | RtP\textsc{wD} |
| \textbf{a. [des enfants sages]} | - | - | * | - |
| b. [des enfants sages] | *! | - | * | - |
| c. [des enfants sages] | *! | - | * | - |
| d. [des enfants] [sages] | *! | - | * | - |
| e. [des enfants] [sages] | *! | - | * | - |
In candidates (a) to (c), the adjective is grouped with the preceding noun, the desired output phrasing. As a consequence, X' category enfants is not marked by a Phonological Phrase boundary on its right, and ALIGNX' is violated. This is not the case for candidates (d) and (e). In order to eliminate them, NoCLASH and RIGHTMOSTPP will have to dominate ALIGNX'. As a result, the other candidate with a clash (b), and the one without the phrase-final accent (c) are also eliminated.

However, the ranking of the constraints in Tableau 6 wrongly predicts that branching complements are also restructured with the preceding noun, as is shown in Tableau 7.

Tableau 7

<table>
<thead>
<tr>
<th></th>
<th>des hivers autres qu'en Afrique</th>
<th>RtPP</th>
<th>*Clash</th>
<th>AIX'</th>
<th>RtPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [des hivers] [autres qu'en Afrique]</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. [des hivers autres] [qu'en Afrique]</td>
<td></td>
<td></td>
<td>**</td>
<td></td>
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</tr>
</tbody>
</table>

In Tableau 7, candidate (b) is wrongly selected as the optimal form, because it satisfies the higher-ranked constraint NoCLASH, and candidate (a) does not. In order to remedy this situation, a conflicting constraint needs to be postulated which interacts with ALIGNX' and NoCLASH. Following Selkirk (1995), we propose to formulate a well-formedness constraint that requires that the right edge of Phonological Phrases coincides with the right edge of a maximal phrasal projection. The constraint ALIGNX" is given in (22) (ALIGNLEXMAX in Selkirk’s terms).16

(22) ALIGNX": Align (X", R; PP, R)

According to (22), all and only X" projections form a Phonological Phrase. Evidently, this constraint conflicts with ALIGNX', because it counteracts the formation of Phonological Phrases on the basis of X' category heads. As shown in Tableau 8, candidates (b) and (d) for des enfants sages incur a violation of ALIGNX", because they contain two Phonological Phrases although both are part of the same X" projection. In des hivers autres qu'en Afrique, all candidates violate the constraint, as the X" projection is parsed as more than one Phonological Phrase. (We assume that candidate (b) is not selected as the optimal form, since the perceptual data on the locations of Phonological Phrase boundaries reported in Chapter 3 suggest that autres normally groups with the following noun in this context). The candidate that best satisfies ALIGNX" and ALIGNX' wins here. Thus, reference to

---

16 Truckenbrodt (1995) proposes to distinguish between ALIGNXP, which enforces the alignment of X" heads with Maximal Phonological Phrases (demarcative constraint), and WRAPXP, which stipulates that all X" constituents are contained in the same Phonological Phrase (cohesional constraint). As is the case with the difference between the constraint which aligns every X' projection with a PP, and the one which aligns every PP with the X' projection, the ranking of the two does not seem to play a role in French, and they are therefore not distinguished here. Selkirk (forthcoming) shows that the two are unranked in English as well. The interaction between ALIGNXP and ALIGNX", however, is crucial to the present analysis, as it constrains the formation of Phonological Phrases below the level of the X" constituent.
ALIGNX” appears to allow us to exclude restructuring across Phonological Phrase boundaries which are non-restructurable in the ‘default’ pronunciation.

Table 8

<table>
<thead>
<tr>
<th>Ides enfants sages</th>
<th>RtPP</th>
<th>AIX”</th>
<th>AIX’</th>
<th>*Clash</th>
<th>RtPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [des enfants sages]</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. [des enfants] [sages]</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [des enfants sages]</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. [des enfants] [sages]</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ides hivers autres qu’en Afrique</th>
<th>RtPP</th>
<th>AIX”</th>
<th>AIX’</th>
<th>*Clash</th>
<th>RtPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [des hivers] [autres qu’en Afrique]</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. [des hivers] [autres] [qu’en Afrique]</td>
<td><em>!</em></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [des hivers] [autres] [qu’en Afrique]</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. [des hivers autres] [qu’en Afrique]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tableau 8 shows that the correct candidate (a) for des enfants sages only violates ALIGNX”, as X’ category enfants does not project a Phonological Phrase boundary. It will be selected as the optimal candidate as long as ALIGNX’ is dominated by RIGHTMOSTPP (cf. candidate (c)), and ALIGNX” and/or NOCLASH (cf. candidate (b)). In order to establish whether ALIGNX” and NOCLASH both outrank ALIGNX’ we have to consider the candidates for des hivers autres qu’en Afrique. The optimal candidate shows that satisfaction of ALIGNX’ leads to a violation of ALIGNX”, because a Phonological Phrase boundary intervenes between the X’ projections. In candidate (d), ALIGNX” is also violated, but here, ALIGNX’ is violated as well, since the boundary does not coincide with an X’ projection (i.e. autres is a lexical head, but not an X’ head). However, candidate (a) violates NOCLASH, which is not the case for candidate (d). This means that candidate (d) will be selected, unless ALIGNX’ dominates NOCLASH. The relative ranking of RIGHTMOSTPP and ALIGNX” cannot be established on the basis of these candidates.

However, although this constraint hierarchy predicts that X’ category words will only restructure with a following word when it is an X’ category word as well, there is still no reason why it should not restructure with the whole of the following X’ projection, as long as both belong to the same X” projection. That is, if ALIGNX” is not counteracted in some way, it enforces restructuring too strongly, as shown in Tableau 9. In candidates (e) and (f) in the tableau, the whole of the X” projection is restructured into one Phonological Phrase. Candidate (e) best satisfies the constraints, because unlike candidate (a), it does not violate NOCLASH. Since only 10% of the items of the experiment reported in Chapter 3 was actually realised in this way, this candidate should not fall out as the optimal one from the ‘default’ dominance hierarchy. Ranking ALIGNX’ above ALIGNX” (and NOCLASH) will not help, as it would make the wrong prediction for des enfants sages (cf. Tableau 8).  

---

17 Note that distinguishing between the constraint which aligns every X” projection with the
ApparentIy, a conflicting length requirement constrains the number of syllables that can be regrouped with a preceding lexical head, which can be independently motivated by the finding that Phonological Phrases usually contain three or four, and maximally six or seven syllables (Pasdeloup 1992b; Delais 1995; cf. Verluyten 1982). The relevant constraint is given in (23).

(23) PPLENGTH(1): Maximally one syllable follows the first X’ projection in a Phonological Phrase.

PPLENGTH(1) belongs to the family of constraints PPLENGTH that regulate the length of prosodic constituents. Tableau 10 shows that the effect of ALIGNX” is counteracted by the constraints ALIGNX’ and PPLENGTH(1) (abbreviated as LENGTH1 in the tableaux). Since none of the candidates for des enfants sages violate PPLENGTH(1), its ranking is irrelevant to the selection of the optimal form. This is not the case for the evaluation of the candidates for des hivers autres qu’en Afrique. The tableau shows that candidate (e) will only be rejected if PPLENGTH(1) dominates the constraints violated by candidate (a), ALIGNX” and NOCLASH.

---

Phonological Phrase and the one that aligns every Phonological Phrase with the X” projection cannot resolve this issue, since it would always exclude either restructuring in des enfants sages or non-restructuring in des hivers autres qu’en Afrique, regardless of their ranking relative to each other and to the other constraints in the hierarchy.

18 For the present purpose, the length requirement could also refer to (prosodic) words instead of syllables, but we follow the predominant view in the French literature here by assuming that the relevant constituent is the syllable. As a consequence, sequences of lexical words as in des enfants intelligents are predicted to surface as two Phonological Phrases rather than one in the ‘default’ description, as opposed to sequences such as des enfants sages.

19 For instance, the related constraints PPLENGTH(2) and PPLENGTH(3) prohibit Phonological Phrases with more than two or three syllables after the X’ head. They would be ranked at the top of the hierarchy, but are irrelevant to the present discussion. By contrast, PPLENGTH(0) would eliminate all candidates with restructuring, and therefore, it has to be dominated by NOCLASH in order to eliminate candidate (b) in Tableau 8. However, as it does not play a role in the elimination of the non-optimal candidates at issue, it is not included in the discussion. Delais’ constraint MAX, according to which a Rhythmic Group cannot contain more than six syllables, would also belong to this family (Delais 1995).
Table 10

<table>
<thead>
<tr>
<th>Ides enfants sages</th>
<th>RiPP</th>
<th>Length1</th>
<th>AIX*</th>
<th>AIX'</th>
<th>*Clash</th>
<th>RtPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [des enfants sages]</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. [des enfants] [sages]</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [des enfants sages]</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. [des enfants] [sages]</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ides hivers autres qu'en Afrique</th>
<th>RiPP</th>
<th>Length1</th>
<th>AIX*</th>
<th>AIX'</th>
<th>*Clash</th>
<th>RtPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [des hivers] [autres qu'en A...]</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. [des hivers] [autres] [qu'en A...]</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [des hivers] [autres] [qu'en A...]</td>
<td></td>
<td>*</td>
<td>*!</td>
<td></td>
<td>!</td>
<td></td>
</tr>
<tr>
<td>d. [des hivers autres] [qu'en A...]</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>e. [des hivers autres qu'en A...]</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. [des hivers autres qu'en A...]</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 11 shows that the interaction of the constraints also makes the correct predictions for phrases which end in a non-head, such as Prends-le and Il dort peu.  

Table 11

<table>
<thead>
<tr>
<th>Il dort peu</th>
<th>RiPP</th>
<th>Length1</th>
<th>AIX*</th>
<th>AIX'</th>
<th>*Clash</th>
<th>RtPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [il dort peu]</td>
<td></td>
<td>*!</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. [il dort] [peu]</td>
<td>*!</td>
<td></td>
<td>**</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [il dort] [peu]</td>
<td>*!</td>
<td></td>
<td>**</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. [il dort] [peu]</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. [il dort] [peu]</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In candidates (a) to (c), the adverb peu is grouped with the preceding X' category word dort. (b) and (c) are rejected because in addition to ALIGNX', they violate either RIGHTMOSTPP or NOCLASH. Candidate (d) has one violation of ALIGNX'' and another of ALIGNX', as dort forms a Phonological Phrase on its own. Finally, candidate (e) is rejected because the non-head is not included in any Phonological Phrase, which leads to two violations of ALIGNX''.

In sum, seven conflicting well-formedness constraints were proposed in this section to account for the interaction between the prosodic structure and the distribution of word-final pitch accents in French. They are ranked according to the dominance hierarchy given in (24).

---

20 Following Selkirk (1995), all non-heads in phrase-final position are assumed to be parsed as prosodic words in the present proposal, whether they belong to a lexical category (e.g. peu in il dort peu) or not (e.g. le in preneds-le). The prosodic parsing of non-final function words is prevented by the constraint PWDCON, which requires that all Prosodic Words are lexical words (i.e. the counterpart of WdCON; Selkirk 1995). The generation of a single Phonological Phrase marked by a final pitch accent in cases such as preneds-le shows that PWDCON is a violable constraint (ranked below ALIGNX').
RIGHTMOSTPP, WdCon and PPLENGTH(1) are undominated constraints, because violations of these constraints are always fatal. Their ranking relative to each other can therefore not be established. They dominate ALIGNX', which was found to be violable when competing candidates violated one of the higher-ranked constraints. ALIGNX" was found to outrank both ALIGNX' and NOCLASH, and ALIGNX' was shown to dominate NOCLASH. Finally, RIGHTMOSTPWD was found to be ranked at the bottom of the hierarchy. Table 12 shows that this constraint hierarchy correctly predicts the optimal output candidates for the data discussed so far.

Table 12

<table>
<thead>
<tr>
<th>Items</th>
<th>WdCon</th>
<th>RpPP</th>
<th>Length1</th>
<th>AIX'</th>
<th>Clash</th>
<th>RpPWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>*a. [de (jolis) (airs)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. [de (jolis) (airs)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>c. [de jolis (airs)]</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*a. [de (jolis) (enfants)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. [de (jolis) (enfants)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>c. [de (jolis) (enfants)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>*a. [des (enfants) (sages)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. [des (enfants) (sages)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>c. [des (enfants) (sages)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>*a. [des (hivers) (autres) ...]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. [des (hivers) (autres) ...]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>c. [des (hivers) (autres) ...]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>*a. [il (dort) (peu)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. [il (dort) (peu)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>c. [il (dort) (peu)]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
</tbody>
</table>

However, these constraints still cannot account for the fact that Clash Resolution cases surface with two rather than one pitch accent, as is shown in (25).

(25) a. [de (jolis) \_pwd (airs)\_pwd] \_PP *[de (jolis) \_pwd (airs)\_pwd] \_PP
   b. [des (enfants) \_pwd (sages)\_pwd] \_PP *[des (enfants) \_pwd (sages)\_pwd] \_PP

21 The relative ranking of RIGHTMOSTPWD and ALIGNX' can only be established indirectly, as NOCLASH dominates RIGHTMOSTPWD while it cannot dominate ALIGNX'.

---

1. The relative ranking of RIGHTMOSTPWD and ALIGNX' can only be established indirectly, as NOCLASH dominates RIGHTMOSTPWD while it cannot dominate ALIGNX'.
All candidates in (25a) and (25b) violate the same constraints (RIGHTMOSTPWD and/or ALIGNX’), and as a consequence, the correct forms cannot be distinguished from the forms in which the first Prosodic Word has no accent. The same applies to lexical words with more than two syllables, which were also shown to surface with two pitch accents in Section 4.2. The realisation of secondary accents is addressed in the following section.

4.3.2. Secondary accents

An additional constraint is required which enforces the realisation of secondary accents, in order to avoid long sequences of unaccented syllables (e.g. Pasdeloup 1992b; Delais 1995). Four constraints could be considered for generating this secondary accent (cf. footnote 14 above), given in (26):

\[(26) \text{NONFINALITY: } \text{the prosodic head of the word does not fall on the word-final syllable}\]
\[
\text{NO LAPSE: adjacent unaccented syllables are not permitted} \\
\text{LEFTMOSTPWD: } \text{Align (PWd, L; Pitch Accent, L): every Prosodic Word must have a pitch accent on its left-hand side} \\
\text{LEFTMOSTPP: } \text{Align (PP, L; Pitch Accent, L): every Phonological Phrase must have a pitch accent on its left-hand side}
\]

NONFINALITY has been proposed to account for the avoidance of stress on word-final syllables in a great number of languages (Prince and Smolensky 1993). As can be seen in Tableau 13, NONFINALITY could only serve to eliminate the non-optimal candidates for de jolis enfants and une assez jolie jupe (prosodic parsing into Phonological Phrases and Prosodic Words is not indicated in the following tableaux; WORDCON, RIGHTMOSTPP, ALIGNX'' and ALIGNX' eliminate candidates that are not parsed correctly). In the tableau, RIGHTMOSTPWD dominates NONFINALITY, and thus correctly selects the optimal candidates for de jolis enfants and une assez jolie jupe. However, independent of their ranking, the optimal forms cannot be distinguished from their non-optimal counterparts in de jolis airs and la nécessité.22

---

22 NONFINALITY may in fact play a role in the avoidance of stress/pitch accents on word-final latent schwas in French.
Delais (1995) proposes to account for initial accents by means of the constraint NO LAPSE.\(^{23}\) She motivates NO LAPSE on the basis of several corpus studies which showed that an accent is realised every two or three syllables. Like NONFINALITY, the constraint would have to be ranked below RIGHTMOSTPWD in order to account for *de jolis enfants* and *une assez jolie jupe*, but the output candidates for *la nécessité* still cannot be evaluated correctly, as is shown in Tableau 14.\(^{24}\)

Therefore, we have to conclude that NO LAPSE alone cannot account for the realisation of secondary accents in French either.

---

**Tableau 13**

<table>
<thead>
<tr>
<th>Idé jolis enfants</th>
<th>RfPWd</th>
<th>NonFin</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. de jolis enfants</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>b. de jolis enfants</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c. de jolis enfants</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>lune assez jolie jupe</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>a. une assez jolie jupe</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b. une assez jolie jupe</td>
<td>**!</td>
<td>*</td>
</tr>
<tr>
<td>c. une assez jolie jupe</td>
<td>**!</td>
<td>*</td>
</tr>
<tr>
<td>Idé jolis airs</td>
<td>RfPWd</td>
<td>NonFin</td>
</tr>
<tr>
<td>a. de jolis airs</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b. de jolis airs</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. de jolis airs</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>la nécessité</td>
<td>RfPWd</td>
<td>NonFin</td>
</tr>
<tr>
<td>a. la nécessité</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. la nécessité</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. la nécessité</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

\(^{23}\) In Delais’ definition of NO LAPSE, sequences of more than two unstressed syllables are prohibited. It makes essentially the same predictions for the cases at issue as the constraint NO LAPSE adopted here.

\(^{24}\) In view of the conflicting reports on the realisation of secondary accents in lexical words with more than three syllables that are given in the literature, one could argue that the acceptability of candidate (c) for *la nécessité* in Tableau 13 cannot function as the decisive argument against NO LAPSE. However, NO LAPSE predicts that words like *la préméditation* always surface with three pitch accents, which is unlikely to be the most commonly occurring pattern.
Like RIGHTMOSTPWd and RIGHTMOSTPP, LEFTMOSTPWd and LEFTMOSTPP belong to the family of constraints which regulate the association of pitch accents (or tonal morphemes) with the phonological structure. According to the constraint LEFTMOSTPWd, initial accentuation is a property of the Prosodic Word, and it enforces the realisation of a pitch accent on the initial syllable of every lexical word. LEFTMOSTPP only requires Phonological Phrases to have a pitch accent at their left-hand boundary. Although it may seem counterintuitive to assume that every lexical word is in principle marked by two pitch accents, LEFTMOSTPP, which makes essentially the same predictions, would require a further stipulation to prevent it from aligning pitch accents with phrase-initial function words (i.e. *la nécessité). Therefore, we have chosen to adopt LEFTMOSTPWd here. Tableau 15 shows that the over-generation of pitch accents by LEFTMOSTPWd is constrained by its interaction with RIGHTMOSTPWd and NOCLASH. When RIGHTMOSTPWd outranks LEFTMOSTPWd, the correct prediction is made for all cases discussed so far.  

---

25 The number of violations for LEFTMOSTPWd given in Tableau 15 shows that we assume that the Prosodic Word not only has a pitch accent at its left edge, but also that this pitch accent has to be aligned with the edge itself: the number of syllables that are not accented is counted from the left edge. Thus, the constraint is different from RIGHTMOSTPWd, which only demands the presence of an accent; its distance to the right edge does not play a role. Thus, strictly speaking, our interpretation of LEFTMOSTPWd collapses the constraints Align (PWD, L; Pitch accent, L) and Align (Pitch accent, L; Pwd L), while RIGHTMOSTPWd does not. As a consequence, we assume that Prosodic Words without accents have only one violation of LEFTMOSTPWd: Align (PWD, L; Pitch accent, L) is violated, but its counterpart Align (Pitch accent, L; Pwd L) is not, since no pitch accent has been introduced. In our account, Align (Pitch accent, R; Pwd, R) and Align (PWD, R; Pitch accent, R) could in fact also be collapsed in RIGHTMOSTPWd. We have decided not to do so, because it would complicate our line of reasoning.
However, the interaction between RIGHTMOSTPWd and LEFTMOSTPWd cannot account for the finding that some polysyllabic words are accented on the second syllable rather than the first. This suggests that an additional constraint is needed which stipulates that syllables with onsets are better candidates for accentuation than onsetless syllables. This requirement could be formalised as PEAKPRoMINENCE (Prince and Smolensky 1993). For ease of exposition, the constraint is formulated as (27) here.

(27) PEAKPRoMINENCE: Pitch-accented syllables have an onset in the morphological word

According to (27), a syllable with an onset (CV) is a better location for a pitch accent than a syllable without an onset (V). As consonants are usually syllabified with the following vowel in the surface form (e.g. l'impossibilité: /lɛ.pɔ.si.bi.li.tɛ/), the constraint has to specify that the onset of the syllable belongs to the morphological word.26

PEAKPRoMINENCE will have to be assumed to dominate LEFTMOSTPWd to account for l'impossibilité, and both are dominated by NOCLASH, as can be seen in Tableau 16.

---

26 That is, a syllable that aligns with a morpheme boundary is a better location for a pitch accent than one that does not. Prince and Smolensky's PEAKPRoMINENCE refers to the intrinsic prominence of syllables (higher sonority elements make better syllable peaks; Prince and Smolensky 1993:38-39).
Tableau 16

<table>
<thead>
<tr>
<th>l'impossibilité</th>
<th>*Clash</th>
<th>PkProm</th>
<th>LfPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. l'impossibilité</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. l'impossibilité</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. l'impossibilité</td>
<td>**!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. l'impossibilité</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>la nécessité</td>
<td>*Clash</td>
<td>PkProm</td>
<td>LfPWd</td>
</tr>
<tr>
<td>a. la nécessité</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. la nécessité</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. la nécessité</td>
<td><em>!</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>le c'est étonnant</td>
<td>*Clash</td>
<td>PkProm</td>
<td>LfPWd</td>
</tr>
<tr>
<td>a. c'est étonnant</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. c'est étonnant</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c. c'est étonnant</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

However, Tableau 16 reveals that the candidates for *c'est étonnant* cannot be evaluated correctly on the basis of LEFTMOSTPWD and PEAKPROMINENCE alone. This means that there is a conflicting constraint that requires Phonological Phrases to surface with two pitch accents, as in (28).

(28) HAMMOCK: A Phonological Phrase is marked by two pitch accents

RIGHTMOSTPWD and LEFTMOSTPWD ensure that the pitch accents introduced by HAMMOCK are aligned with the edges of prosodic words, unless this creates a clash, as is shown in Tableau 17. The tableau also shows that PEAKPROMINENCE has to be dominated by HAMMOCK; there is no evidence for a dominance relation between RIGHTMOSTPWD and PEAKPROMINENCE.

Tableau 17

<table>
<thead>
<tr>
<th>l'impossibilité</th>
<th>*Clash</th>
<th>Ham</th>
<th>PkProm</th>
<th>RtPWd</th>
<th>LfPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. l'impossibilité</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. l'impossibilité</td>
<td>*!</td>
<td></td>
<td></td>
<td><em>!</em></td>
<td></td>
</tr>
<tr>
<td>c. l'impossibilité</td>
<td>*!</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>d. l'impossibilité</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. l'impossibilité</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>le c'est étonnant</td>
<td>*Clash</td>
<td>Ham</td>
<td>PkProm</td>
<td>RtPWd</td>
<td>LfPWd</td>
</tr>
<tr>
<td>a. c'est étonnant</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. c'est étonnant</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. c'est étonnant</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>le de jolis airs</td>
<td>*Clash</td>
<td>Ham</td>
<td>PkProm</td>
<td>RtPWd</td>
<td>LfPWd</td>
</tr>
<tr>
<td>a. de jolis airs</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. de jolis airs</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. de jolis airs</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>
Instead of HAMMOCK, NO LAPSE could be adopted to account for c’est étonnant, but in that case, words with more than four syllables would always be realised with three instead of two pitch accents (i.e. l’impossibilité). HAMMOCK avoids making this prediction explicit, while capturing the observation that Phonological Phrases are usually marked by ‘accentual arcs’.

HAMMOCK cannot be an undominated constraint, as it would eliminate all candidates that do not surface with two pitch accents. Tableau 18 shows that it is ranked below NOCLASH.²⁷

Table 18

<table>
<thead>
<tr>
<th>Ides hivers autres qu’en A...l</th>
<th>RtPP</th>
<th>AIX*</th>
<th>AIX’</th>
<th>*Clash</th>
<th>Ham</th>
<th>RtPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [des hivers] [autres...]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td>b. [des hivers] [autres] [...]</td>
<td>**!</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>lil dort peul</th>
<th>RtPP</th>
<th>AIX*</th>
<th>AIX’</th>
<th>*Clash</th>
<th>Ham</th>
<th>RtPWd</th>
</tr>
</thead>
</table>

Note that the introduction of HAMMOCK limits the functionality of LEFTMOSTPWd in the ‘default’ dominance hierarchy to the evaluation of candidates for polysyllabic lexical words (cf. candidate (c) for l’impossibilité in Tableau 17).

In sum, three additional constraints have been postulated to describe the distribution of secondary accents in French: HAMMOCK, PEAKPROMINENCE and LEFTMOSTPWd.

4.3.3. Summary

The interaction between ten well-formedness constraints is proposed to account for pitch accent distribution in French. The full constraint hierarchy arrived at is the following:

(29) WDCON, RIGHTMOSTPP, PPLENGTH(1) >> ALIGNX” >> ALIGNX’ >> NOCLASH >> HAMMOCK >> PEAKPROMINENCE, RIGHTMOSTPWd >> LEFTMOSTPWd

²⁷ HAMMOCK is similar to RIGHTMOSTPP, which enforces the realisation of phrase-final pitch accents. The two cannot be collapsed, as for instance candidate (b) for il dort peu in Tableau 19 could no longer be distinguished from the optimal candidate. Whether candidate (d) violates HAMMOCK is not entirely clear. As the tableau shows, this is irrelevant to the evaluation of the output forms.
As shown in Tableau 19, the accentual patterns that were most commonly observed in the production experiment reported in the previous chapter are described by the proposed dominance hierarchy. Moreover, the description captures the location of secondary accents in polysyllabic lexical words.

**Tableau 19**

<table>
<thead>
<tr>
<th>Ide jolis airts</th>
<th>WdCn</th>
<th>RtPP</th>
<th>Length</th>
<th>AIX*</th>
<th>AIX'</th>
<th>*Clash</th>
<th>Ham</th>
<th>PkPr</th>
<th>RPWd</th>
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<tr>
<td>[de (jolis) (airs)]</td>
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<td>lde jolis enfants</td>
<td>WdCn</td>
<td>RtPP</td>
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<td>AIX*</td>
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<td>*Clash</td>
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<tr>
<td>ldes enfants sages</td>
<td>WdCn</td>
<td>RtPP</td>
<td>Length</td>
<td>AIX*</td>
<td>AIX'</td>
<td>*Clash</td>
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<tr>
<td>ldes hivers autres qui en Al</td>
<td>WdCn</td>
<td>RtPP</td>
<td>Length</td>
<td>AIX*</td>
<td>AIX'</td>
<td>*Clash</td>
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<td>PkPr</td>
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<td>[des (hivers) (autres) ...]</td>
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<tr>
<td>prends-le</td>
<td>WdCn</td>
<td>RtPP</td>
<td>Length</td>
<td>AIX*</td>
<td>AIX'</td>
<td>*Clash</td>
<td>Ham</td>
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<td>[(prends)(le)]</td>
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<tr>
<td>lune assez jolie jupel</td>
<td>WdCn</td>
<td>RtPP</td>
<td>Length</td>
<td>AIX*</td>
<td>AIX'</td>
<td>*Clash</td>
<td>Ham</td>
<td>PkPr</td>
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<td>[une (assez)(jolie)(jupel)]</td>
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<tr>
<td>ll'impossibilite</td>
<td>WdCn</td>
<td>RtPP</td>
<td>Length</td>
<td>AIX*</td>
<td>AIX'</td>
<td>*Clash</td>
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<td>[(l'impossibilite)]</td>
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<tr>
<td>lc'est etonnant</td>
<td>WdCn</td>
<td>RtPP</td>
<td>Length</td>
<td>AIX*</td>
<td>AIX'</td>
<td>*Clash</td>
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<td>[c'est (etonnant)]</td>
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The most obvious advantage of this analysis is that it does not require transformations of underlying forms that are formalised in questionable rewrite rules such as Clash Resolution and Restructuring. This also means that there is no longer any need for positing different phonological structures that represent very similar surface forms. However, it still needs to be established whether an Optimality approach can also handle prosodic variation in French.

4.4. Prosodic variation

Although the experimental results reported in the previous chapter largely supported the predictions made by Prosodic Phonology, the realisation of pitch accents was found to vary in two respects:

I. Restructuring did not take place, and all X’ category words were realised with a phrase-final pitch accent (e.g. des enfants sages in 27% of cases).

II. Branching complements were also restructured with the preceding noun, and the pitch accent in the first Phonological Phrase was realised word-initially to avoid a clash, i.e. the phonological Phrase coincides with the X’ projection (e.g. des hivers autres qu’en Afrique in 9% of cases).

In addition, variation occurs in the realisation of secondary pitch accents, which appears to be independent of phrasing:

III. A PP-internal word-final pitch accent is lost in favour of an initial accent, even when it is not motivated by the avoidance of a clash (Fónagy and Fónagy 1976; Di Cristo and Hirst 1984; Mertens 1992; Pasdeloup 1992b; Vaissière 1992; Delais 1994; Di Cristo to appear) (e.g. de petits enfants).

IV. Non-final pitch accents in the Phonological Phrase are omitted (e.g. de jolis airs; cf. Chapter 3 Section 3.5.3.2.; 9% of all cases).

Evidently, an adequate account of pitch accent distribution in French will have to be able to describe these findings. We aim to show in this section that this can be done successfully by means of partial ranking. The subsets of unranked constraints are crucially ranked relative to the other constraints in the grammar, which restricts the number of possible output forms. In this way, the description can predict which forms surface in cases of prosodic variation, and still exclude ungrammatical output forms. Partial ranking can thus be said to reflect the sensitivity of postlexical processes to factors such as speaking rate. The constraints involved in these rerankings (i.e. the constraints of the unranked subsets) are the ones which regulate, for instance, the widening of a domain of application of a process in the case of variations in speaking rate.

4.4.1. Variation in Phonological Phrase formation

The first type of phrasal variation entails the production of a greater number of word-final accents. Nevertheless, the realisation of a word-final accent within the
Small Phonological Phrase in, for instance, *jolis in *de jolis airs*, which would lead to a clash, is prohibited at all times. Therefore, the modification of the dominance hierarchy should be minimal. The promotion of ALIGNX' has the required effect, as is illustrated in Tableau 20.

Tableau 20

<table>
<thead>
<tr>
<th>Phrase</th>
<th>Length</th>
<th>AIX'</th>
<th>AIX''</th>
<th>*Clash</th>
<th>Ham</th>
<th>RtpWd</th>
</tr>
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<tr>
<td><em>de jolis airs</em></td>
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<tr>
<td>a. [de (jolis) (airs)]</td>
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<td>b. [de (jolis) (airs)]</td>
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<tr>
<td>c. [de (jolis) (airs)]</td>
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<tr>
<td>ides enfants sages</td>
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<tr>
<td>a. [des (enfants)</td>
<td>(sages)]</td>
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<tr>
<td>b. [des (enfants)</td>
<td>[sages)]</td>
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<tr>
<td>c. [des (enfants)</td>
<td>[sages)]</td>
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<tr>
<td>ides hivers autres qu'en Afrique</td>
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<tr>
<td>a. [des (hivers)</td>
<td>[autres)]]</td>
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<td>b. [des (hivers)]</td>
<td>[autres)]</td>
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<tr>
<td>c. [des (hivers)]</td>
<td>[autres)]</td>
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<tr>
<td>d. [des (hivers)]</td>
<td>[autres)]</td>
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</table>

Tableau 20 shows that when ALIGNX' applies in full force, all X' words are aligned with a Phonological Phrase boundary on their right-hand side. This leads to the selection of the output form for *des enfants sages* that has a Phonological Phrase break between the lexical words and two word-final accents. As predicted, this minimal adjustment of the constraint hierarchy does not affect the selection of the optimal candidates for *de jolis airs* and *des hivers autres qu’en Afrique*. The tableau also shows that the ranking of ALIGNX' relative to the other constraints at the top of the hierarchy is irrelevant, as the optimal form never incurs any violations for the constraint. In other words, ALIGNX' has taken the position of ALIGNX'' in the ‘default’ hierarchy.

The opposite tendency also occurs, and appears to be characteristic of fast speech (Fougeron and Jun 1998). In this case, X'' projections that contain a lexical head followed by a branching complement, such as *des hivers autres qu’en Afrique*, are realised without an internal break and the accentual pattern that characterises Clash Resolution is produced. This means that the size of Phonological Phrases is no longer constrained by PPLENGTH(1), as is shown in Tableau 21.

A comparison of the dominance hierarchy given in Tableau 21 and the ‘default’ hierarchy presented in the previous section again reveals only one difference, that is, PPLENGTH(1) is demoted. As before, the selection of the optimal candidates for *de jolis airs* is not affected. The prediction is that the optimal form for phrases like *des enfants sages* is the same as that selected by the ‘default’ constraint hierarchy, which is very likely.
In conclusion, phrasal variation can be described concisely and insightfully when we assume that three constraints, PPLength(1), ALIGNX'' and ALIGNX', are variably ranked relative to each other in the grammar, as is indicated by the square brackets in (30) (comma’s separate constraints for which the dominance relation cannot be established).

(30) Dominance hierarchy:

\[
\text{WDCon, RTPP}>[\text{Length1}, \text{ALX}'', \text{ALX}']>*\text{Clash} > \text{Ham} > \text{PkPr, RTPWd} > \text{LtP WD}
\]

Variant 1: ‘Default’:

\[
\text{WDCon, RTPP}>\text{Length1} > \text{ALX}'' > \text{ALX}' > *\text{Clash} > \text{Ham} > \text{PkPr, RTPWd} > \text{LtP WD}
\]

Variant 2: No restructuring:

\[
\text{WDCon, RTPP}>\text{Length1} > \text{ALX}'' > \text{ALX}' > *\text{Clash} > \text{Ham} > \text{PkPr, RTPWd} > \text{LtP WD}
\]

Variant 3: Always restructuring (dephrasing):

\[
\text{WDCon, RTPP}>\text{ALX}'' > \text{Length1} > \text{ALX}' > *\text{Clash} > \text{Ham} > \text{PkPr, RTPWd} > \text{LtP WD}
\]

Thus, the interaction between ALIGNX'' and ALIGNX' offers two methods for generating Phonological Phrases, while PPLength(1) constrains their size. Speakers are free to choose among the legitimate options, as their relative ranking is not set in the grammar. The options available are strictly limited, because the subset formed by PPLength(1), ALIGNX'' and ALIGNX' is crucially ranked relative to the other constraints in the grammar. In this way, the system is sufficiently flexible, without generating ungrammatical forms.

### 4.4.2. Variation in the realisation of non-final pitch accents

The second type of variation in prosodic structure concerns pitch accent placement only. Recent research has shown that in sequences of lexical words that are closely
related in meaning, such as *Beaujolais primeur*, there is a tendency for the pitch accent on the first word to be realised on the initial instead of the final syllable (see Di Cristo to appear for a discussion). The phenomenon, which is referred to as the "accentual bi-polarisation principle" by Di Cristo, has the effect of emphasising the internal cohesion of the elements in the phrase. The phenomenon can result in ambiguities, because word boundaries are no longer signalled in the prosody, as exemplified in (31) (example from Di Cristo to appear).

(31) *des personnalités*  
    * *  
    * *  

*des personnes alitées*  
    * *  

In such realisations, the initial pitch accent is enforced at the cost of the word-final pitch accent, while it does not affect Phonological Phrase-final pitch accents. Tableau 22 shows that the situation is captured in the present analysis by inverting the dominance relation between RIGHTMOSTPWD and LEFTMOSTPWD.28

Tableau 22

<table>
<thead>
<tr>
<th></th>
<th>RtPP</th>
<th>*Clash</th>
<th>Ham</th>
<th>LTPWD</th>
<th>RTPWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>*a. [des jolis enfants]</td>
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<td>*</td>
<td>*</td>
<td></td>
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<tr>
<td>b. [des jolis enfants]</td>
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<td>**!</td>
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</tr>
<tr>
<td>c. [des jolis enfants]</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>*a. [des personnes alitées]</td>
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</tr>
<tr>
<td>b. [des personnes alitées]</td>
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<tr>
<td>*a. [des personnalités]</td>
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<td>*</td>
<td></td>
</tr>
<tr>
<td>b. [des personnalités]</td>
<td></td>
<td></td>
<td>***!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [des personnalités]</td>
<td></td>
<td>***!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*a. [lune assez jolie jupel]</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. [lune assez jolie jupel]</td>
<td></td>
<td></td>
<td></td>
<td>**!</td>
<td></td>
</tr>
<tr>
<td>c. [lune assez jolie jupel]</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>*a. [des personnes alitées]</td>
<td></td>
<td></td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. [des personnes alitées]</td>
<td></td>
<td></td>
<td>***!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [des personnes alitées]</td>
<td></td>
<td>***!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*a. [des (personnalités)]</td>
<td></td>
<td></td>
<td>*!</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>b. [des (personnalités)]</td>
<td></td>
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<td></td>
<td></td>
<td>***</td>
</tr>
<tr>
<td>c. [des (personnalités)]</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*a. [lune grande jupel]</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. [lune grande jupel]</td>
<td></td>
<td></td>
<td></td>
<td>**!</td>
<td></td>
</tr>
</tbody>
</table>

28 In order to arrive at the correct prediction for *des personnes allitées*, the constraint hierarchy of Tableau 20 is assumed to apply, where ALIGNX' dominates PLENGTH(1) and ALIGNX'.
In Tableau 22, the forms predicted by the 'default' hierarchy, given as candidate (b) for the top three input forms, are all eliminated by LEFTMOSTPWD. As the bottom two examples show, this slightly modified constraint hierarchy correctly selects the same output forms as the 'default' hierarchy when the Phonological Phrase contains only one word or two monosyllabic words. Moreover, the (c) candidates show that undominated RIGHTMOSTPP still rules out candidates without a phrase-final pitch accent (de jolis enfants). Also, HAMMOCK eliminates output forms with only one pitch accent (une assez jolie jupe, des personnes altées and des personnalités), unless the realisation of the two pitch accents creates a clash (une grande jupe 'a big skirt'). Thus, while the inversion of RIGHTMOSTPWD and LEFTMOSTPWD enforces initial accentuation, it does not affect the phrase-final pitch accent, or the avoidance of clashes. This means that the grammar has a second set of variably ranked constraints, RIGHTMOSTPWD and LEFTMOSTPWD, resulting in the constraint hierarchy given in (32).

\[(32) \quad \text{Dominance hierarchy:} \]
\[
\text{WDCon,RtPP} >> \text{[Length1,ALX","ALX']} >> \\
*\text{CLASH} >> \text{HAM} >> \text{PKPR} >> \text{[RtPWD,LtPWD]} \\
\]

Phonological Phrases can also be realised with a single phrase-final pitch accent, which appears to be particularly the case in fast speech (e.g. Fougeron and Jun 1998; cf. the cases reported in Chapter 3). As may be clear, the constraints that were discussed so far only serve to enforce the presence of pitch accents. Consequently, the dominance relations holding between them can never prevent pitch accents from surfacing. This means that partial ranking cannot account for this type of variation, and that an additional constraint is called for which prohibits the alignment of accents with prosodic structure. The constraint can be independently motivated on the grounds that in long Phonological Phrases, pitch accents do not normally surface on every other syllable either (NOCLASH would only eliminate strings of immediately adjacent pitch accents), and is given in (33).\footnote{The phenomenon may be related to variation in the location of the secondary accent in words with more than three syllables, such as l'impossibilité, where a minority is realised with a word-initial pitch accent (Pasdeloup 1990b cited in Beaugendre 1994). Such cases could be analysed in the present description by including PEAKPROMINENCE in the variably ranked set, in which case it could be demoted below LEFTMOSTPWD.}

\[(33) \quad \text{NOACCENT:} \quad \text{Pitch accents are prohibited.} \]

NOACCENT is an anti-association constraint that prevents the parsing of a feature, in this case the feature 'pitch accent' (i.e. a phonological markedness constraint; Prince and Smolensky 1993). It conflicts with HAMMOCK, and with the constraints that regulate the alignment of pitch accents. Obviously, NOACCENT is a violable constraint. In the 'default' hierarchy of the preceding section, HAMMOCK would have

\footnote{NOTONE (**T; Gussenhoven forthcoming) would make the same predictions. We refer to the constraint as NOACCENT only because the tonal structure of the pitch movement is not relevant to this discussion.}
to dominate it. Tableau 23 shows that all candidates with non-final pitch accents fail the evaluation when the dominance relation between the two is reversed.

<table>
<thead>
<tr>
<th>Ile jolis enfants</th>
<th>RtPP</th>
<th>*Clash</th>
<th>*Accent</th>
<th>Ham</th>
<th>LtPWd</th>
<th>RtPWd</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [de jolis enfants]</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>b. [de jolis enfants]</td>
<td></td>
<td>**</td>
<td></td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [de jolis enfants]</td>
<td></td>
<td>*</td>
<td></td>
<td>**</td>
<td>**</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ides enfants sages</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [des (enfants)(sages)]</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. [des (enfants)(sages)]</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>c. [des (enfants)(sages)]</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

In the tableau, the effect of HAMMOCK, RIGHTMOSTPWd and LEFTMOSTPWd, which demand the occurrence of pitch accents, is annihilated. Yet, the Phonological Phrase still surfaces with a final pitch accent, which is enforced by undominated RIGHTMOSTPP.

4.5. Conclusion

The Optimality analysis proposed in this chapter was shown to be successful in describing the complex interaction between phonological phrasing and pitch accent assignment in French. The location of pitch accents in 'normal' speech is described by the prioritisation of a limited set of universal well-formedness constraints. The crucial interaction of phonological unmarkedness and alignment constraints allows us to select grammatical pitch patterns only, including those where a clash is at play. Moreover, prosodic variation was shown to arise automatically from the crucial non-ranking of small sets of constraints, where rerankings resulting in possible variants were minimal, while categorically ungrammatical realisations were still excluded.

The most obvious advantage of the constraint-based account is that allows us to give a unified account for French accentuation by putting the explanatory burden on the well-formedness of outputs instead of the way in which they are derived in the grammar. First, the analysis does not need to make a questionable distinction between ‘default’ pitch accent distribution on the one hand, and patterns induced by Clash Resolution and/or restructuring on the other. Second, the same grammatical principles account for the sensitivity of Phonological Phrase formation to length in terms of syllables and for the behaviour of phrase-final non-heads. Third, the emergence of gradient variation through partial rankings avoids the arbitrary stipulation of exceptions to rules that appear to be categorical in different contexts. For instance, Clash Resolution is to all intents and purposes obligatory in Small Phonological Phrases, but it applies variably in Maximal Phonological Phrases. In a rule-based approach, such variation could only be accounted for by means of
optional exceptions or additional rules which transform phonological structures created at earlier stages in the derivation process. In the present proposal, categorical and gradient variation are both accounted for by means of the same grammatical principles. A single grammar with minimally variable constraint rankings theoretically restricts the variation that is predicted to occur, which allows the system to be sufficiently flexible, without generating ungrammatical forms.

In fact, the demotion or promotion of a single constraint was found to capture variation in phonological phrasing and the location of pitch accents. The interaction between the variably ranked constraints ALIGNX", ALIGNX' and LENGTH(1) regulates variation in phonological phrasing. When the domain of application of phonological processes such as Clash Resolution is diminished, for instance in extremely careful slow speech, ALIGNX' overrules the competing constraint ALIGNX" in French. The opposite effect of domain widening (or dephrasing), which can be observed in fast speech, involves the demotion of LENGTH(1) below ALIGNX". Stated in more general terms, these minimal rerankings can be said to reflect the expected sensitivity of postlexical processes to factors such as boundary weight and rate of speech. As a consequence, the analysis predicts that the widening of the domain of application of phonological processes in other languages will involve minimal rerankings of the same, or at least closely related, constraints in those languages.31

The account of variation in the realisation of secondary accents entails a similar prediction. The occurrence of hammock-shaped patterns such as Beaujolais Nouveau appears to primarily depend on speaking style, being more frequent in 'didactic' speech (e.g. conference presentations), radio and television news bulletins, and political speeches (see Di Cristo to appear for an overview). In the present account, such hammock-shaped patterns are predicted to arise when LEFTMOSTPWD dominates RIGHTESTPWD. In a sense, the domain of application of HAMMOCK is widened by this demotion of RIGHTESTPWD. Although the constraints involved in the enforcement of pitch accents on lexical items will be different in other intonation languages, this analysis entails that similar processes are expected to arise there. In fact, the French pattern is strongly reminiscent of Rhetorical Retraction in Dutch (Gussenhoven 1984:333-345), which also applies variably and appears to depend on speaking style, used for instance in political speeches and commercials (e.g. commercieel beleid instead of non-retracted commercieel beleid ‘commercial policy’).

Finally, the partial ranking of HAMMOCK and NOACCENT captures a variant in which only phrase-final pitch accents are realised. In the terms of the present proposal, higher-ranking NOACCENT obliterates the effect of HAMMOCK altogether. Thus, the minimal reranking of HAMMOCK and NOACCENT can be seen as complementary to the reduction of the number of pitch accents through dephrasing, as such patterns also tend to arise in fast speech. However, it remains unclear to what

31 Which constraints exactly are the relevant ones in a particular language obviously depends on the way in which the phonological domains of application are derived in the language in question.
extent rerankings occur simultaneously in the different unranked subsets in a particular speaking situation.

This means that the factors that influence the speaker’s choice for particular pitch patterns will need to be further investigated in order to evaluate the explanatory power of partial ranking, as is the case for any model of language variation. Evidently, this investigation did not aim at clarifying those factors, but the framework adopted in the present proposal allows for a unified description of prosodic variation depending on factors such as speaking rate and style, while it still excludes the selection of ungrammatical pitch patterns.
Chapter 5  Phonological contrasts and phonetic variation in French pitch movements

Traditionally, descriptions of French intonation recognise a system of oppositions between rising, rising-falling and falling pitch movements, which function contrastively at the end of major prosodic constituents.¹ More recently, a general consensus has also arisen about non-final pitch movements, rises associated with the last full syllable of a lexical word and with the initial syllable of a polysyllabic lexical word (Di Cristo and Hirst 1984; Mertens 1986; Post 1993; Jun and Fougeron 1995). However, there is little agreement about the phonological distinctions that arise from variation within these categories and their phonological representation.

The aim of this chapter is to identify the differences in pitch movements that should be captured by a phonological description of the intonation system. For this purpose, the realisation of French intonation contours was investigated in two speech corpora. As is to be expected, not all of the observed variation in the pitch traces represented phonological contrasts. That is, some differences could be assumed to be variants of the same phonological category. The data were compared with findings in the literature in order to have an even larger data set on the basis of which we could establish which variations in the pitch trace could be assumed to function as tonal contrasts.

The data on which the analysis is based are described in Section 5.1. In sections 5.2 and 5.3, the pitch movements observed in the corpora are presented. Movements which occur at Intonation Phrase boundaries (‘IP-final’) and those that occur within the Intonation Phrase (‘IP-internal’) are treated separately. This means that the pitch movements are discussed with reference to the Intonation Phrase alone; the Phonological Phrase does not play a role in the tonal description. In competing Autosegmental-Metrical accounts of French, tones project prosodic constituents (e.g. the AP in Jun and Fougeron’s account, and the TU in Di Cristo and Hirst’s account; see Chapter 2 section 2.2). This is not the case here. Although the Phonological Phrase determines which metrically strong syllables receive a pitch accent (Chapters 3 and 4), the tonal specification of the accents themselves is independent of the prosodic structure. The tonal morphemes are listed in the phonological inventory, and speakers select these for association with the appropriate locations. In other words, the Phonological Phrase should be seen as a rhythmic rather than a tonal unit. Section 5.4 gives an overview of the differences in pitch movements that should be distinguished at the phonological level.

¹ Note that these term are not intended to reflect intonational categories used in the British tradition (see Section 5.1.4.2). Some descriptions only mention the contrasts with reference to the utterance, but sometimes lower-level constituents, such as the IP, are also explicitly referred to (cf. Chapter 2).
5.1. Method

A phonological description of the intonation system of a language should obviously capture all phonological contrasts produced by speakers in connected speech. In order to increase the likelihood that our analysis fulfils this aim, a wide variety of samples of intonation contours in different contexts needed to be collected, and an appropriate method for their analysis be found. The following subsections describe how the data were collected and analysed. In Section 5.1.1, the methodological choices made for the recordings are motivated. Sections 5.1.2 and 5.1.3. give details about the elicitation methods, the subjects and the recording procedures for the two speech corpora. The acoustic and auditory analyses of the corpus data are presented in Section 5.1.4.

5.1.1. Factors in the choice of elicitation methods

The elicitation methods used in this study needed to provide a sufficiently wide variety of intonation contours for all phonological categories of the intonation system to be present, while allowing for a distinction between systemic and realisational differences to be made. The first requirement entailed that different speaking styles needed to be included, as they are known to give rise to different prosodic patterns. Thus, the number and location of pitch accents, prosodic boundaries, pauses, etc. are different in read and spontaneous speech (see Bruce and Touati 1990a, 1990b and Martin 1999 for the investigation of prosody in spontaneous speech in French). Also, the interaction between speakers in a dialogue will result in a higher frequency of intonation contours associated with, for instance, turn-taking and questions, than in a monologue. Moreover, speaking styles will depend on the audience. For instance, a speaker will adapt his intonation contours when he reads a story to a small child instead of a news bulletin on the radio.

In order to identify the phonologically relevant features of the movements elicited, the data needed to be comparable across speakers and utterances. That is, we wanted to be able to filter out variation which was likely to result from contextual differences alone (segmental, semantic, or otherwise). Recording a number of speakers allowed us to compare pitch movements produced in the same context. This meant that the subjects’ socio-economic or cultural backgrounds, age, geographic origin, sex, and education had to be as similar as possible.

Two speech corpora were collected to provide the data for the tonal analysis: (a) a corpus of read speech, in which four speakers read a version of the fairy tale Cendrillon ‘Cinderella’, and (b) a corpus of spontaneous speech, where speech was elicited by means of the Map Task (Brown et al. 1984). In a Map Task, two subjects are given a map with landmarks, and the one on whose map a route is drawn along these landmarks is to inform the other how to copy this route onto his map. Both elicitation methods have been applied successfully in intonation research (Map Task: Anderson et al. 1991; Grice et al. 1995; Farrar et al. to appear; Fairy tale: Post 1993; Grabe 1998a; Farrar et al. to appear). We assumed that the two tasks would
provide the required variety in intonation contours as they were concerned with very different language functions, while at the same time allowing for sufficient control over the speakers' productions.

Experimental control would be highest in the reading task, as context effects, vocabulary, prosodic structure, grammatical function and semantic interpretation are to a large extent determined by the text chosen. A well-known fairy tale, moreover, is likely to lead to the same interpretation of the text and the use of more stereotypical intonation contours, which makes direct comparisons of the realisations of tonal categories across speakers and utterances easier. Also, the events in fairy tales generally involve strong emotions, which will induce speakers to use a wide variety of intonation contours. Finally, when speaking to a child, speakers are likely to speak relatively slowly and carefully, and they use larger pitch excursions, which facilitates the auditory and acoustic analysis of the intonation contours.

Spontaneous speech elicited in a Map Task is obviously less controlled. Although speakers will also tend to speak carefully and explicitly in order to transfer the relevant information efficiently, they are unlikely to produce longer and more complex sentences, and not all utterances will be complete. Also, speakers are likely to often resort to the same communication strategies, which may result in the elicitation of a more limited set of intonation contours than in the fairy tale. Yet, it is the latter characteristic, combined with constant reference to the same landmarks, which allows direct comparisons between speech samples to be made. The advantage of the Map Task compared with a reading task is that the subjects will concentrate on communicating successfully rather than on their speech.

Since the acoustic analysis of corpora of this size is very time-consuming, a thorough study of the spontaneous speech materials was not feasible. The analysis was therefore primarily based on the read speech corpus, supplemented by data from the spontaneous corpus whenever necessary. Some additional examples were included from a controlled production experiment that was performed as part of a project on the acquisition of English and French intonation at the Phonetics Laboratory of Oxford University, which will be referred to as the Oxford corpus (Grabe et al. 1998b). This was done because the experiment provided clear evidence for a distinct contour in a way not found in our corpus data (an utterance-final globally rising-falling movement; Section 5.2.5). Also, an acoustic analysis was performed in order to establish whether the contours elicited showed systematic differences in alignment when they were associated with utterances of varying length, for which the less controlled data of the other two corpora were unsuitable.

5.1.2. The read speech corpus: Cendrillon

Cendrillon 'Cinderella' was chosen for the recordings, because it is one of the best-known fairy tales in France. In the construction of the text used, three criteria were taken into account. Firstly, the story line had to be presented in a way that was familiar to the subjects to help them produce a natural reading. Secondly, a wide variety of syntactic structures and discourse functions needed to be incorporated to
elicit a great number of different intonation contours that could be compared across contexts. Thirdly, the use of non-sonorant segments needed to be avoided to facilitate the acoustic analysis.

For this purpose, two subjects were asked to tell the fairy tale by means of a set of ten line drawings that depicted the main events in the story. The subjects, who did not participate in the reading task, were native speakers from the same age group and background as the subjects in the experiment (the instructions are included as Appendix B1). In this way, we tried to ensure that the text was a close representation of the story as it was known to the experimental subjects. The version of the text that was created on the basis of these recordings was adapted to comply with the second and third criteria as closely as possible. The final version included simple statements, various co-ordination and subordination structures, relative clauses, morpho-syntactically marked questions, exclamations, commands, direct and reported speech, syntactic tags and appositions. Moreover, the morpho-syntactic structure of phrases was varied (see Appendix B3). The elimination of obtrusants (criterion three) was less successful, since the forced use of all-sonorant words sometimes threatened to change the story beyond recognition.

Two female and two male subjects, aged twenty-one to twenty-six, were recruited from the student population of the University of Nijmegen. Two speakers were exchange students from Paris, and the other two were regular students (from Paris and Yvelines) in the French department. All had arrived or returned from France briefly before the recordings, which took place after a one-month Christmas break in January 1998. The subjects were recorded on digital audio tape (DAT) in the sound-treated studio of the Arts Faculty of the University of Nijmegen. They were instructed to read the text before the recording started, to try and speak as clearly as possible and to avoid producing background noises. They were asked to pretend they were telling the story to a small child (see Appendix B2). As the speakers might have felt more inhibited at the beginning of the recordings, they were recorded twice, and the first recording was discarded. The speakers were not informed of the purpose of the experiment. Details about the prosodic structures produced by the speakers, such as the number of Intonation Phrases and pitch accents, are included as Appendix B4.

5.1.3. The spontaneous speech corpus: Map Task

In a Map Task experiment, one subject (the Instruction Giver) has a map with a route that connects a number of landmarks depicted on it, and the other (the Instruction Follower) has a slightly different map on which only landmarks and the starting point of the route are given. The subjects are not able to see each other's maps. The landmarks are represented as line drawings with labels that identify them. Most of the landmarks are identical on the two maps, but some are different with respect to their location or label. Also, a landmark may be absent or given twice in one of the maps, or two similar landmarks occur on the map which only differ in a minor feature, such as *le bel étang* 'the pretty lake' as opposed to *le profond étang*
‘the deep lake’ in our experiment (see Appendix B5). This is done to involve both subjects in different speech acts or to elicit specific linguistic expressions, while generally encouraging a lively interaction. Subjects are asked to read the list of landmarks at the end of the recording session, so that pronunciations of the landmarks during the Map Task can be compared with their canonical realisations.

To increase the likelihood that comparable speech samples were elicited from all speakers, each subject participated as the Instruction Giver in one session, and as the Instruction Follower in another. For this purpose, two sets of maps of comparable complexity were designed. The maps are included as Appendix B6.

Four French exchange students from Paris, three women and one man, participated in the experiment. They were aged between twenty and twenty-two, and knew each other rather well. This was done in order to make them feel at ease with each other, and to help them to concentrate on the task from the start and forget about the recording situation more quickly.

The recordings were made on DAT-tape in the above-mentioned studio in May 1996. The subjects were placed approximately two metres apart, such that they could not see each other or each other’s maps. The maps were printed on A3 size paper and pasted onto cardboard. The subjects were told that the maps were not identical and that they could say anything they liked to reach their goal, as long as they tried not to speak simultaneously (see Appendix B7). They were not told about the purpose of the experiment. The total duration of the recordings was approximately 30 minutes. An orthographic transcription of the tapes is included as Appendix C.

5.1.4. Acoustic and auditory analysis
The recordings were digitised at 16KHz on a Silicon Graphics Indy™ workstation and divided into speech files of approximately one minute each. The data were analysed acoustically by means of the Entropic waves+™ signal processing package. All data were transcribed orthographically, and the fundamental frequency traces, produced by the xwaves formant procedure, were inspected to identify halving and doubling errors. The auditory analysis was performed by means of (1) a transcription system and (2) classification of the pitch patterns. These methods will be discussed in the following subsections.

5.1.4.1. Transcription of the corpus data
A transcription procedure was followed that allowed us to directly compare the intonation contours in the corpora. The procedure is directly derived from IViE, a labelling tool developed for the transcription of intonational variation of the dialects of the British Isles by Esther Grabe and colleagues at Cambridge University (Grabe et al. 1998a).² IViE is different from other Autosegmental-Metrical transcription systems in that it distinguishes between a phonological and a phonetic level of the transcription.

² The IViE labelling guide is currently available on the web at http://www.mml.cam.ac.uk/ling/ivyweb/guide.html
transcription, a feature which was crucial to our analysis, as at this stage, we could obviously not decide on the appropriate phonological analysis of the intonation contours. Thus, initially, what Abercrombie refers to as a "general phonetic" or "impressionistic" transcription could be made, in which the symbols represent general human categories of sound, before the distinctive categories of the system of the language in question were identified, as is the case in a "systematic transcription" (Abercrombie 1964:35-36). As in ToBI (Tones and Break Indices; Silverman et al. 1992), which was developed for the transcription of American English intonation, a script is used which introduces a separate transcription window between the xwaves waveform window and the fundamental frequency window. The advantage of such systems is that the transcriber can combine information provided by the fundamental frequency trace with his auditory impression, and perceptually non-salient characteristics of the fundamental frequency trace, such as consonantal perturbations, can be ignored. IViE shares three levels of transcription with ToBI: (1) the extra tier, for miscellaneous remarks, (2) the phonological tier, for the transcription of the tones, and (3) the orthographic tier. They are given as the top two tiers and the bottom tier, respectively, in the transcription window (centre) in Figure 1. The intermediate auditory phonetic and rhythmic tiers in the figure are unique to this transcription system.

In the system, the data can be transcribed orthographically in the bottom tier shown in Figure 1, where each word is aligned with the right edge of the word in the waveform. The rhythmically prominent syllables are indicated on the rhythmic tier by marking the syllable with '<' and '>' on either side. In this way, one can record which syllables are perceived as more prominent (due to lengthening, higher amplitude, a pitch movement, or a combination of such phonetic correlates).

The auditory phonetic tier is used to transcribe the perceptually salient features of the pitch movement around the accented syllables. The auditory impression of the pitch level of the accented syllable is given relative to the level of the preceding and the following syllable as low, mid or high, i.e. the labels do not represent absolute values. As can be seen in Figure 1, the pitch level associated with the accented syllable is represented by a capital letter. Whenever a marked change in level occurs within the accented syllable, a combination of two labels is used to indicate the change, e.g. 1_MH on question in Figure 1. Thus, it reflects the auditory impression of each pitch movement. The advantage of the auditory phonetic level is that perceptually salient and non-salient features can be distinguished, which makes the motivations for assigning phonological labels to a contour (in the phonological tier) more transparent.

The phonological tier is used for the transcription of phonologically distinct intonational categories that are associated with stressed syllables and boundaries. Miscellaneous remarks can be transcribed in the top tier of the system. Halving and doubling errors, interruptions, and 'non-standard' pronunciations, such as the word-final schwa in filles in Figure 1, are indicated here.

The read speech data were partly transcribed in this way, but the spontaneous data were only labelled orthographically.
5.1.4.2. Classification of the pitch movements

The second part of the auditory analysis was applied to all data, and originated from the need to create an overview of the observed pitch movements. The speech files were inspected in the windows provided by the transcription system and the auditory impression of the pitch movements was summarised in a text file with pictures that represented the global shape of the movement in and around the accented syllables. In the file, a first grouping was made on the basis of the direction of the pitch movement around the accented syllable: falling, rising, rising-falling, falling-rising, and level pitch, exemplified in Figure 2.

As the figure shows, for an IP-internal movement to be classified as a falling movement, pitch had to be falling in the unaccented syllables before and after the accented syllable, creating an overall falling impression. Cases in which either the preceding or following unaccented stretch was level (indicated by the dotted lines) were also classified as falling. For the IP-internal rising movement, pitch had to be rising before and after the accented syllable; level pitch before or after the rising stretch also qualified as rising. In IP-internal falling-rising movements, the lowest
point had to be reached in the accented syllable. In rising-falling movements the reverse was the case. For an IP-final pitch movement to be classified as falling, pitch had to fall from the preceding unaccented stretch onto the final accented syllable, i.e. the lowest point was located in the accented syllable. In IP-final rising movements, the highest point was reached in the accented syllable. For the classification of IP-final falling-rising and rising-falling movements variation in pitch in the accented syllable was referred to, as shown in the figure. In the first case, the lowest point had to be followed by rising pitch in the accented syllable, and in the second, the highest point was followed by falling pitch.

<table>
<thead>
<tr>
<th>IP-internal</th>
<th>IP-final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falling</td>
<td>Falling</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Falling-rising</td>
<td>Falling-rising</td>
</tr>
<tr>
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Figure 2: Grouping on the basis of pitch direction. Filled circles represent the accented syllables, lines pitch in the unaccented syllables around it, and dotted lines represent variants. In the IP-final falling-rising and rising-falling movements pitch in the accented syllable is represented by bold lines, and bold dotted lines represent variants.

Within each group, pitch movements were further subdivided according to the pitch level attained (e.g. fall to mid versus fall to low), their location in the utterance (utterance-final, IP-final, or within the IP) and the number of pitch accents that preceded them. This is illustrated in Figure 3, which gives an excerpt of the section that is concerned with the falling movements. In the figure, overall falling movements in IP-internal position are subdivided on the basis of the direction of the movement in and around the accented syllable. The bold line indicates fundamental frequency in the accented syllable, which was either slightly falling (types 1 and 2) or level (type 3). Fundamental frequency before the accented syllable was at the same level, or it fell from the preceding high target, indicated by the filled circle in Figure 3. The thin dotted lines and open circles indicate variants. As can be seen, the classification abstracts away from local fundamental frequency perturbations, but differences within the movement that cannot be straightforwardly attributed to the intrinsic properties of the segments are recorded.
1.2. Falling movements to mid: IP-internal

I. one or more preceding high pitched accents within the same IP:

Type 1 (10)  
(3)

Type 2 (3)  

Type 3

Type 1:
- sb3: commandaient de ranger leurs affaires
- sb9: avec de jolis gants de dentelle (dentelle pitch jump!)
- fd10: il y a une condition
- ?co5: tu n'es pas fait pour ce monde-là : accent on Tu or downstep from %H?

Type 2:
- fd&sb13: les douze coups de minuit sonnent
- cg13: gblouj par sa beauté,... (note: humps rather than level, but sounds level)

Type 3:
- cg9: une magnifique robe de soie
- fd18: Venez essayez cette pantoufle
- fd9: avec de jolis gants de dentelle (dip for /g/) etc.

Figure 3: Excerpt of the classification file (read speech corpus). Bold lines indicate the accented syllable, circles mark the surrounding accented syllables, and dotted lines give the observed variants of each type.

In the read speech corpus, the speech samples in which the pitch movements were observed were listed below the panels, as can be seen in Figure 3. The code referred to the speech file (e.g. sb3), and the underlined syllables indicated the location of the pitch accents of interest. The number of occurrences of each type was counted in order to have an impression of their relative frequency. The classification file for the spontaneous speech corpus did not include this information.

In this way, an overview was created of the observed similarities and differences in the pitch movements, irrespective of their contrastive function.

5.2. IP-final pitch movements

A grouping of the pitch movements in IP-final position on the basis of the overall shape of the movement as rising, rising-falling, and falling is given as (a) to (c) in Figure 4. The movement illustrated in (d) can be considered either as rising-falling or as falling, and is therefore not labelled in this way. This grouping in Figure 4 reflects the generally recognised set of contrasts that occur in IP-final position (Coustenoble and Armstrong 1934; Armstrong and Jones 1967; Fónagy and Béard...
Apart from these uncontroversial oppositions, a number of other discretely different contours have been claimed to exist about which there is less agreement in the literature. In an overall rising movement, for instance, pitch excursion differences are often assumed to lead to categorical distinctions. Thus, the representations in Figure 4 may ignore some of the fundamental frequency variation which also leads to categorical distinctions. The discussion in this section takes the grouping of Figure 4 as its starting point in order to facilitate the presentation of the great number of conflicting claims about gradient and discrete differences in French intonation contours. Observed variation in rising movements, rising-falling movements, falling movements, and movements with a fall from a peak in the penultimate unaccented syllable will be examined separately. This method of presentation is not intended to imply that these contrasts are in any way subordinate to the uncontroversial contrasts, but merely reflects the relative lack of agreement on further distinctions. For convenience, three aspects are distinguished in the discussion: (1) variation in the start of the overall movement (onset), (2) variation in the range of the pitch excursion, and (3) variation in the location of peaks and dips, as shown in Figure 5.

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3 A great number of other authors also distinguish between rising, falling and rising-falling movements. They are not mentioned here, because their descriptions refer to the global contour of the prosodic unit, and as a consequence, it is not entirely clear to what extent their claims can be interpreted to hold for the localised representations of the patterns in Figure 4. For instance, they may or may not distinguish between the pattern in (d), where the peak occurs on the penultimate unaccented syllable and that in (b), where the preceding peak would be located on an accented syllable (also Di Cristo and Hirst 1996).
Variability:

1. Onset of movement e.g.

2. Pitch excursion e.g.

3. Location peak and dip e.g.

Figure 5: Three aspects of the movement distinguished in the discussion of variation: (1) the onset of the movement, (2) pitch excursion, and (3) the location of peaks and dips. The filled circles highlight the relevant locations in the pitch movements.

This section starts with a brief presentation of the generally accepted oppositions in IP-final position. The more controversial contrasts will be identified in Sections 5.2.2. to 5.2.5., and Section 5.2.6. summarises the findings.

5.2.1. Uncontroversial contrasts

The four uncontroversial IP-final contours are illustrated in Figure 6 on the utterance Marianne est venue 'Marianne has come' with two accented syllables, on -rianne and -nue. The IP-final movement in (a) represents intonation contours that have a final rise. In an IP-final rising-falling movement (b), pitch in the penultimate syllable rises towards a peak in the final accented syllable, and is followed by a fall in that syllable. The final rising-falling movement contrasts with the final fall illustrated in (c), which is characterised by a drop in pitch to the bottom of the speaking range from a preceding peak, which can be located on a preceding accented syllable or at the initial IP boundary. In movement (d), pitch falls from a peak in the penultimate syllable, which is not accented.
In order to illustrate the importance attributed to this four-way distinction, we will now discuss the main functions that have been associated with the pitch movements in the literature. The list is by no means exhaustive, nor should it be interpreted to imply that there is a one-to-one relationship between form and function. The reason why it is given here is that functional differences between the pitch movements have often been the crucial argument for the authors cited to assume that the four types of movement are phonologically contrastive.

Final rises are generally assumed to be associated with exclamations, unfinished statements (continuation), or total questions (i.e. unmarked declarative questions and questions marked by inversion or est-ce que) (Coustenoble and Armstrong 1934; Delattre 1966; Armstrong and Jones 1967; Fónagy and Bérard 1973; Boé and Contini 1975; Martin 1975a; Mertens 1992; Léon 1992; Di Cristo and Hirst 1993, 1995; Di Cristo 1998; Di Cristo et al. to appear). That is, the final rise in the example given in Figure 6 could signal an exclamation, for instance because the speaker is delighted to see that Marianne has finally arrived. In a different context, the rise could indicate that the speaker signals continuation. When applied to the example in the figure, a continuation interpretation would indicate that the speaker has not finished his sentence, as in for instance an enumeration of the type Marianne est venue, Pierre est venu, Paul est venu, mais Anne n’a pas voulu venir ‘[…] but Anne did not want to come’. The third important function of final rises is the signalling of a question. In the example, interrogativity is not morpho-syntactically marked, which means that a question interpretation would be based on the intonation contour alone (declarative question). The morpho-syntactically marked variants of the same question Marianne est-elle venue? and Est-ce que Marianne est venue? would normally be realised with a final rise as well (Di Cristo 1998). Some authors have claimed that there are consistent differences in the

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**Figure 6:** Stylised representations of the four uncontroversial oppositions in IP-final position. The dotted lines represent pitch of the unaccented syllables, the filled circles indicate the peak associated with the accentuated syllable -rianne, and the bold line represents the IP-final pitch movement in the accentuated syllable -nue.
realisation of final rises associated with questions, continuations and exclamations. These claims will be discussed briefly in the following section, and addressed more extensively in Chapter 7.

The function of the rising-falling movement in Figure 6 (b) can be stated in general terms to signal a speaker’s involvement with his message (Delattre’s implication 1966). As Mertens (1986:26) puts it, the rising-falling movement makes the relation between what is said and who says it explicit, implying that the speaker attributes some special importance to (part of) his message. Hence, its use to signal “emphasis for contrast”, where the final word or group of words is (implicitly) contrasted with those in a preceding utterance (narrow focus at the end of the utterance), as in Marianne est partie? Non, Marianne est venue! ‘Marianne has left? No, Marianne has come’ (Coustenoble and Armstrong 1934; Armstrong and Jones 1967; Leach 1988; Di Cristo and Hirst 1996; Jun and Fougeron to appear). In a different context, a speaker can use a rising-falling movement to indicate that what he says is indisputable, obvious (Marianne est venue. – Can’t you see? She’s standing right there; Dell 1984). When used in a question, the movement may convey incredulity or doubt (Marianne est venue? – I can’t believe it; Fónagy and Bérard 1973), and the speaker does not ask a genuine question (Grundstrom 1973).

The final fall is mostly used in declarative utterances, where it signals assertion (finality), but it is also reported to be the typical contour chosen in commands, in interrogatives that are marked by a question word, and in elliptical questions such as Et Marianne? ‘And Marianne?’ (Coustenoble and Armstrong 1934; Delattre 1966; Armstrong and Jones 1967; Martin 1975a, 1975b; Mertens 1987; Leach 1988; Léon 1992; Di Cristo and Hirst 1993, 1995; Di Cristo 1998).

The movement in Figure 6 (d), is claimed to be mainly used in assertions (Coustenoble and Armstrong 1934; Contini and Boë 1973). According to Di Cristo and Hirst (1996), statements with a penultimate peak sound more convivial than those with a falling movement, whereas Mertens (1986, 1987) claims that they signal detachment on the part of the speaker. It has also been suggested that in questions, the movement conveys greater uncertainty than a rising or a falling movement (Fónagy and Bérard 1973).

5.2.2. Rising movements

A large number of IPs in the corpora was realised with a rising pitch movement. As was pointed out above, three aspects are distinguished in the discussion of the observed variation in rising movements in this section: variation in the onset, the

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4 In Delattre’s description, this rising-falling movement does not reach the bottom of the speaking range (a fall from a peak at level 4 to level 3). Implications of this difference for the phonological description of the movement will be discussed in Section 5.2.3.

5 In the read speech corpus, 187 Intonation Phrases out of 386 had a final rise, 9 of which occurred in utterance-final position (8 were yes/no questions). In the spontaneous speech corpus, the relative frequency of IP-final rises appeared to be even higher.
pitch excursion, and the timing of the turning points in the movement (cf. Figure 5). Figure 7 illustrates the observed variation in the onset of the rising movements.

![Figure 7: Stylised contours representing variation in the onset of IP-final rising movements in one-accent IPs (left column; rising or level) and IPs with more than one pitch accent (right column; falling or level). The IP-final accented syllable is indicated by a bold line; filled circles represent the peak of the preceding pitch accent.](image)

When there was only one accented syllable in the phrase, fundamental frequency rose throughout the Intonation Phrase, or from the syllable that precedes the accented syllable. Whenever the rising movement was preceded by another (IP-internal) pitch accent, it started much later, usually from a point before the IP-final syllable. The pitch movement on the intervening unstressed syllables was always realised as a straight interpolation between the peak on the first accent and the starting point of the rise.6

A comparison between the realisations of the four speakers in the read speech corpus strongly suggests that in one-accent IPs, the rising and level onsets varied freely. In Figure 8, speaker SB’s realisation has rising pitch throughout the IP, whereas in the realisations of speakers FD and CO, the final rise is preceded by a low level stretch.7

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6 An immediate rapid fall followed by rising pitch to the end of the IP was never observed in the corpora (also Pasdeloup 1992b). The falling-rising patterns between two high pitch accents described by Coustenoble and Armstrong (1934) and Martin (1975b) could be interpreted to contradict this claim, but in their descriptions, the lowest point of the movement is always associated with a stressed syllable at the end of a group (cf. Section 5.3.2).

7 The tiny dip in F0 in speaker SB’s realisation coincides with the /t/. Appendix D explains how the figure was made.
Figure 8: Realisations of the onset of the rise in the one-accent IP *Sa marraine,* ‘Her godmother...’ The realisations in the top panels are those of the female speakers, those at the bottom are the male speakers. The accented syllable is underlined in the phonetic transcription and marked by a shaded box.

To our knowledge, this difference has never been claimed to function contrastively.\(^8\) A comparison between these realisations and those in Figure 9, where pitch is slightly falling from the preceding peak on *mots*, illustrates the difference between final rises in one-accent IPs (level or rising onsets) and IPs with more than one accent (slightly falling onsets).

Figure 9: Realisations of the onset of the rise in the two-accent IP *...les mots de sa marraine,* ‘...the words of her godmother,...’ (Speakers FD and SB; the others produced a falling movement). Grey shading indicates the non-final accented syllable, and both accented syllables are underlined in the phonetic transcription.

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\(^{8}\) According to Delattre (1966), the overall shape of the rising movement is concave as opposed to convex in questions and continuations, but experimental evidence has shown that the difference is not consistent (Di Cristo 1976; Rossi 1978; Romdas 1992 cited in Di Cristo 1998).
The falling slope between the accented syllables can be reduced to a slight sag, especially when there are only one or two intervening syllables (cf. Jun and Fougeron 1995), or fundamental frequency falls more rapidly and stays level before the final rise (cf. Pasdeloup 1992b). This variation does not appear to function contrastively.

An alternative realisation was observed in which fundamental frequency continued at the level of the peak in the preceding pitch accent and rose in the final syllable of the IP, described as a 'high plateau' by Jun and Fougeron (to appear). In Figure 10, speakers CG and FD (the women) produce a more or less high level stretch before the final rise, whereas speakers CO and SB produce a slight fall onto the pre-final syllable -vec.

![Figure 10: Final rises preceded by a high plateau in [Voulez-vous danser cette] valse avec moi? 'Would you like to dance this] waltz with me?' (speakers CG and FD). As before, the final accented syllable is given in the box; grey shading marks the IP-internal accented syllable.](image)

The examples in the figure suggest that the level plateau may play a role in the signalling of questions. However, as questions marked by final rises in which there is no such plateau are perfectly normal, the plateau cannot be a consistent cue for
interrogativity. Yet, Jun and Fougeron’s study shows that the plateau consistently characterises utterances with early narrow focus (i.e. a focal accent on a non-final word), which suggests that the distinction between falling and high level onsets should be represented in the description of the intonation system.  

The second aspect in which IP-final rising movements were found to vary was the timing of the peak and the dip of the movement. The highest point in the rising movement could be reached at the very end of the final syllable, or earlier, in which case fundamental frequency usually stayed level or fell slightly towards the end of the syllable, as shown in Figure 11.

![Figure 11: Timing of the peak in the final rise in Mademoiselle,... (speaker CO: early & level; speaker SB late & rising).](image)

As amplitude drops rapidly at the end of the accented syllable, the slight falling movement is not perceptually salient (cf. Figure 8 above, where F0 falls slightly in the /n/ of marraine; Fónagy and Bérard 1973). By contrast, an early timing of the peak followed by level pitch has been claimed to contrast with a late peak (Faure 1973). When the peak occurs earlier, the movement from low to high pitch sounds like a rapid jump, and according to Coustenoble and Armstrong (1934), the effect of such a jump is that of emphasis, curiosity, surprise, authority, or irony. Although we think it is possible that the difference affects the attitudinal interpretation of the utterance, we found no evidence for this claim in our data.

Also, the dip before the rise was observed to vary, as is illustrated in Figure 12. The lowest fundamental frequency point was often realised before the accented syllable (‘early rise’, speakers FD and CO), but it could also be located in the accented syllable (‘late rise’, speakers CG and SB).

Different timings of the rise have been claimed to reflect phonologically distinct categories (Mertens 1986, 1987; Di Cristo and Hirst 1996).

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9 For instance, in Di Cristo and Hirst’s description of questions marked by a rise, the movement is always preceded by a fall (Di Cristo and Hirst 1996).

10 The postfocal stretch is realised at a slightly lower level (‘mid plateau’) or at the same level (‘high plateau’) before the final rise (Jun and Fougeron to appear).

11 Mertens’ transcription of the difference as an HH as opposed to an LH accent on the final syllable suggests that the difference is attributed to the timing of the dip. It is not entirely clear to what extent the transcription also reflects a concomitant early timing of the peak (followed by level pitch) in the HH accent.
observations would appear to support this view. In the examples found in the read speech corpus, the timing of the start of the rising movement seemed to have an effect on the attitude or emotion conveyed by the speaker. Thus, speakers CG and SB seem to sound more indignant than speakers FD and CO do in the example in Figure 12.

For similar continuation contexts, Mertens (1987, 1992) has claimed that a late rise sounds more affirmative. More importantly, studies in which realisations of rises in questions and continuations were compared suggest that the starting point of the rise may play a role in distinguishing between them (cf. Chapter 7). However, the realisations of continuations and questions in the Oxford corpus seem to contradict this claim (Grabe et al. 1998b). In the top left panel of Figure 13, the subject produces a list of names, and in the other panels, the same subject asks a question. A comparison of the rise on Marianne in the top left and top right panels is in accordance with the assumption of a distinction, as the dip before the rising movement occurs earlier in the continuation context (left) than in the question context (right). However, the question rise on Marianne in the bottom right panel (one-word utterance) is very similar to that in the continuation context. Moreover, in the realisations of Marie in the top and bottom left panels, the exact opposite relation seems to hold between dip timing and the function of the rise.

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12 Instances of late rises are relatively rare in the read speech corpus, but appear to be the predominant realisation in the spontaneous corpus.
In addition, the read speech data strongly suggest that early and late rises vary freely. In Figure 14, for instance, all four speakers produce a rising movement in the same context. The only respect in which their realisations are different is in the timing of the dip, which varies from speaker to speaker. Given that this Intonation Phrase is not only the very first one of the story, but also the traditional opening line of every fairy tale, it is unlikely that the speakers were trying to convey different meanings. Therefore, our provisional assumption is that the timing of the dip is not involved in a categorical distinction.

The realisations in Figure 14 also show that the range of the rising movement in the accented syllable varies. Although the end of the final rise is usually the highest fundamental frequency point in the Intonation Phrase (speaker SB), the peak of the preceding pitch accent can be higher (speakers CG and FD). Such relative differences in peak height have been claimed to be related to the hierarchical relations holding between the (syntactic) constituents in the utterance, and will be discussed in Section 5.3.2. (IP-internal movements).
Differences in peak height between IP-final rises have been claimed to depend on the grammatical function conveyed by the rise (Faure 1973; Fónagy and Bérard 1973; Grundstrom 1973; Rossi 1981). Thus, Fónagy and Bérard (1973) explicitly distinguish between exclamations, questions, continuations, and statements that convey some sort of implication on the basis of the height of the peak and the steepness of the final rising movement. This analysis implies that at least three distinctive pitch levels (or ranges) should be distinguished in the analysis of rising movements. Although a difference in peak height seemed to be associated with the difference between questions and continuations in the spontaneous speech corpus, our data provided no evidence for more fine-grained distinctions. Moreover, experimental findings have shown that listeners often confuse rises in questions and exclamations (Grundstrom 1973). Therefore, we conclude that a possible three-way contrast in final rises based on pitch excursion is not sufficiently supported by the evidence.

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13 The read speech corpus did not contain a sufficient number of rises in questions and exclamations to allow for a systematic comparison between their realisations and those of continuations.
5.2.3. Rising-falling movements

Rising-falling movements were relatively rare in the speech corpora. In all, about 25 realisations of IP-final rise-falls were found in the read speech corpus.\textsuperscript{14} The predominant realisation of the onset of the movement was a gradual rise when it was the only pitch movement in the phrase, as shown in Figure 15.

![Figure 15: The onset of the IP-final rising-falling movement: gradual rise in *Ma mignon(e) ne parte pa z\e\ u\z\ e \a p\i*! ‘Sweetheart, don’t go, I beg of you!’](image)

Although less frequent, level onsets were also possible (Figure 16), both when there was only one pitch accent in the IP (speakers CO and FD), and when there was a preceding pitch accent (on the *i* of *iras* marked by grey shading in speaker SB’s realisation). Fundamental frequency could also be somewhat lower between the accented syllables, as is illustrated in the bottom panel of Figure 17. To our knowledge, this variation has never been claimed to give rise to phonological distinctions.

\textsuperscript{14} Almost all IP-final rising-falling movements occurred in utterance-final position.
Figure 16: The onset of the IP-final rising-falling movement: level in *Non! Tu n’iras pas!* ‘No! You won’t go!’.

Figure 17: The onset of the IP-final rising-falling movement: falling in ...*ne veut pas qu’elle y aille* ‘...does not want her to go there’ (the other speakers produce final falling movements).

The realisations in Figure 15 to 17 also show that fundamental frequency in the accented syllable is invariably characterised by a fall from the peak in the accented syllable, but the rising part of the movement does not have to be visible. That is, fundamental frequency can be seen to rise and then fall in –*gnonne* (Figure 15) and *aille* (Figure 17), but it falls from a peak at the onset of voicing in *pas* and *prie*.
Pitch movements

(Figure 16). An inspection of the rising-falling movements produced in the corpora suggests that the timing of the peak is linked with the segmental structure of the accented syllable. If its onset is voiceless, the syllable has a straight fall, and if it is voiced, it has a rising-falling realisation. In other words, variation in the timing of the peak appears to be highly predictable, and does not need to be accounted for in the phonological part of the grammar. The lowest point from which the rise started was always located before the final syllable (unless the utterance was monosyllabic). This means that the dip before the rising-falling movement was timed somewhat earlier than that in the rising movements discussed in the previous sections. The height of the peak, which can also be seen to vary, does not seem to function contrastively either. That is, although higher peaks may sound more emphatic, they are not phonologically distinct from movements with lower peaks.

By contrast, the size of the pitch excursion of the falling part of the movement has been claimed to give rise to structurally different intonation contours (Delattre 1966). Movements in which the falling part of the movement reaches the bottom of the speaking range (in Delattre’s notation: 4-1), are distinguished from those in which it does not (2-4). The structural distinction was motivated on the basis of functional differences. Thus, the 4-1 contour represented the *intonation d’exclamation* and the *intonation de commandement*, and the 2-4 contour the *intonation d’implication* (Delattre 1972). The realisations in figure 15 and 17 seem to contradict this claim. Firstly, the falling part of the movement does not always reach the bottom of the speaking range in the exclamations (Figure 15), and secondly, the rising-falling movement on *ailles* (Figure 17), which could be interpreted to signal implication, clearly does not stop at mid level. In view of the absence of a consistent realisational difference, we assume that all IP-final rising-falling movements belong to the same phonological category.

5.2.4. Falling movements

The predominant intonation contour found at the end of the utterances in the read speech corpus was a falling movement from high or mid to low, traditionally referred to as the *intonation de finalité* (Delattre 1966). The pitch movement is usually preceded by another pitch movement within the same Intonation Phrase, as in Figure 18 (top panel), but in a few cases in the read speech corpus, it was the only pitch accent in Intonation Phrase, as shown in the bottom panel of Figure 18.

Although the range of the fundamental frequency pattern in the utterance in the bottom panel is smaller than that in the preceding utterance, the movement is clearly falling, and not level. This implies that Intonation Phrases can start with a high target on a syllable which does not appear to be accented, a phenomenon which is referred to as a ‘high prehead’ or ‘high onset’ in the literature (O’Connor and Arnold 1968:21-25; Gussenhoven 1984:244).

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15 150 utterances out of 176 ended in a fall in the read speech corpus. Their occurrence at the end of utterance-internal IPs was relatively rare (26 cases).
Figure 18: Utterance-final falling movements in ...les douze coups de minuit sonnent ‘...the twelve strokes of midnight sound’ (top), and Tu n’iras pas! ‘You won’t go!’ (bottom); the other speakers have a rising-falling movement. A grey box marks the final accented syllable.

The onset of a final falling movement from a preceding pitch accent was found to take two forms, as exemplified in Figure 19. In the representation on the left, the fall is a straight interpolation between the peak of the pitch accent on -rianne and the final low point in -nue (cf. speaker FD’s realisation of coups de minuit sonnent in Figure 18). In the representation on the right, fundamental frequency continues at the level of the preceding peak before stepping down onto the accented syllable (cf.
speaker CO’s realisation of *minuit sonnent* in Figure 18). In our speech data, the difference between these two realisations was very hard to perceive, and to our knowledge, it has never been claimed to be distinctive.

However, the realisation with the level onset can sometimes be confused with a variant of the movement in which pitch falls from a peak on the penultimate unaccented syllable discussed in the following subsection, and we will therefore return to this issue there.

The examples in Figure 18 above also show that in the accented syllable, fundamental frequency either slightly falls or is low level. These differences cannot be phonologically distinct, because they are not perceptually salient. The non-salience of the direction of pitch in the final syllable can be explained by its extremely low amplitude, which is sometimes so low that the syllable is not even voiced (cf. Rossi 1978).

The third respect in which the falls in our corpora were found to vary was the size of the pitch excursion. Sometimes this was reduced, and at other times the endpoint of the fall was mid instead of low. An overall reduction of the range in falls to low is generally attributed to differences in the focus distribution in utterances (theme-rheme versus rheme-theme; Coustenoble and Armstrong 1934; Delattre 1966; Perrot 1978; Rossi 1981, 1985; Mertens 1990; Adjemian 1987; Wunderli 1987; Ashby 1994). In postposed thematic constituents, for instance, the range can be reduced to the extent that pitch is level. In Figure 20, the reporting clause *lui dit la bonne fée* is realised with low level pitch by speakers FD and CO, while the realisations of the other speakers still fall slightly (see Wunderli 1987 for an extensive study of the realisation of dislocated constituents). In such cases, it is not always clear whether the final syllable of the utterance is actually accented. In utterances with early narrow focus, similar low level realisations have been claimed to be deaccented (Mertens 1986, 1987; Di Cristo and Hirst 1996; Jun and Fougeron to appear).

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16 Also, a hump or minute rise is sometimes visible in the F0 trace.
The data also revealed a difference between falling movements to the bottom of the speaking range and those that only fall to mid. In Figure 21, both types of fall are realised on a morpho-syntactically marked question. Although the difference is barely visible in the pitch traces, the auditory impression of the realisations in Figure 21 confirms that in the first IP, speakers FD and CO produce a fall to mid while speakers CG and SB produce a fall to low, and that the reverse is the case in the second IP. Like the fall to low, the fall to mid stretches from an IP-internal pitch peak to the IP-final accented syllable. The movement can be realised as a straight interpolation between the preceding high target and the low target, but CO’s realisation of *Ma chère petite fille* shows that the preceding unaccented syllables can also be pronounced at the same level as the final syllable.

Falls to low would appear to express more finality than falls to mid. Thus, mid realisations can convey the sense that the utterance has not been completed, as in speakers FD and CO’s realisations of *Ma chère petite fille*. This type of reduction of the range of the falling movement is therefore comparable to that in final rises, where a reduced range has been claimed to be consistently associated with
continuations, as opposed to rises with a wide range which are predominantly associated with questions or exclamations. The lack of a sense of completion in the mid realisations at the end of the utterance seems to create an effect of greater compassion in the context of Figure 21.

In accordance with Gussenhoven (1984), who describes the same difference between pitch accents that run their full course and those which stop at mid level for Dutch and British English as half-completion, we believe that this difference should be captured in the phonology. This assumption is further supported by the finding that IP-final movements where fundamental frequency falls from a peak on the penultimate unstressed syllable also have a distinction between mid and low final pitch.

5.2.5. Movements with a penultimate peak

Unambiguous instances of movements in which fundamental frequency fell from a peak on the penultimate unstressed syllable did not occur in the read speech corpus. In some cases, the pitch movement could in fact represent a contour with two immediately adjacent accented syllables at the end of the IP, as is illustrated in
Figure 22 (top panel) (cf. Chapter 6 section 6.2.4).

**Figure 22**: Ambiguous pitch movements with a fall from a penultimate peak: (a) one IP-final accented syllable, or two immediately adjacent pitch accents (top; bold lines indicate the portion of the contour realised on the accented syllables), and (b) a fall from a penultimate unaccented peak, or an 'ordinary' fall, both preceded by a high level onset (bottom; dotted lines indicate the variants of the contours at issue).

In cases in which the penultimate syllable was clearly not accented, the potential instances could be confused with a falling movement, since here, the peak was preceded by high level pitch, as is illustrated in Figure 22 (bottom panel). The figure shows that such realisations can be interpreted both as a fall with a high level onset, or as a movement with a penultimate unaccented peak, where the dip before the penultimate peak is omitted. An acoustic analysis of the data in the Oxford corpus supported the latter interpretation of the final falls elicited there. It showed that the distance between the highest fundamental frequency value and the lowest point in the final syllable was constant, irrespective of the direction of fundamental frequency that preceded the penultimate syllable (Grabe et al. 1998b). This means that we have to assume that the difference between final falling movements and movements that fall from a penultimate peak can be neutralised in certain contexts.

Although the spontaneous data revealed some unambiguous cases, here, the
movement did not occur very frequently either.\textsuperscript{17} The rarity of the movement in our corpora suggests that it cannot be assumed to be the predominant pattern for neutral assertions, as has been claimed by Armstrong and Jones (1967) and Coustenoble and Armstrong (1934). Our data support the view that instead, the movement is used to convey that the speaker thinks that what he says is evident, or that he does not want to commit himself (Leach 1988; Mertens 1992). This is illustrated in the examples in Figure 23.

The utterance on the left was produced by the Instruction Giver to confirm a correction of the Instruction Follower (IF: \textit{Donc, tout à fait sur la gauche} ‘So [it’s] all the way on the left’ IG: \textit{Toi, tout à droite}. ‘[You,] at the very right’ IF: \textit{Sur la droite}. ‘On the right’ IG: \textit{Sur la droite}. ‘On the right’). The Instruction Giver could be interpreted to sound somewhat impatient or disapproving, because she thinks it is obvious that the landmark is situated on the right (cf. the disapproving or incredulous repetition mentioned by Dell 1984). In the realisation on the left, the Instruction Follower signals that she thinks that her conclusion follows inevitably from the instructions she was given, but she does not want to commit herself to it.

The realisations in Figure 23 ended at the bottom of the speaking range. They contrast with realisations in which pitch only falls to the middle of the range in exactly the same way as the fall to mid discussed in the previous section. That is, mid realisations sound less final, or less complete, than low ones (Coustenoble and Armstrong 1934; Mertens 1992). Thus, in the examples in Figure 24, the speakers signal that the information in the message is evident to them, but this may not be the case for the listener, as she has failed to mention it so far. Therefore, the speaker avoids to sound too conclusive.

\textsuperscript{17} Interestingly, Crompton (1978) also found very few examples of this movement in his corpus of read speech, which is why he chose not to include it in his analysis of French intonation.
Figure 24: IP-final falling movements to mid from a penultimate unaccented peak in *Mais c'est pas celui de toute à l'heure* ‘But it isn't the one we had earlier’ and *J'ai aussi le tonnelier* ‘I also have the cooper’.

According to the authors that have been cited in this subsection so far, the movements with a penultimate peak in an unstressed syllable figure in the basic system of intonational contrasts. However, some authors only describe these movements as intonational clichés (*cliché méloïdique*), implying that they are not part of the basic intonation system of the language, but form a separate, possibly closed class of intonation contours (Fónagy et al. 1979, 1983; Di Cristo 1998). Intonational clichés are usually characterised by sustained pitch in tones with a more or less fixed interval. They are used in conventionalised contexts, signalling some sort of routineness (Ladd 1978:531). The melodic cliché discussed here is reminiscent of a children’s taunt (Fónagy et al. 1983), and is often used to make fun of someone, but it can also be used in calling contours (Di Cristo 1998; see Ladd 1996:136-139 for a discussion of calling contours in various European languages, and Hayes and Lahiri 1992 and Gussenhoven 1993 for two analyses of calling contours which take both tonal and durational facts into account).

In accordance with Di Cristo’s view, we believe that realisations of the movement in which pitch is sustained form a separate class outside the basic intonational system, but this class mirrors a set of movements with the same tonal structure (i.e. falls from a penultimate peak to mid and to low) that function within the basic system. The difference between the two can be attributed to stylisation (Ladd 1978; Gussenhoven 1984), which is a feature that is independently present in the grammar, and can apply to other basic movements as well (see Fónagy et al. 1983 for a discussion of other French intonational clichés). An example of a stylised realisation of the movement, where pitch stops at mid level, is given in Figure 25. When they have successfully completed the Map Task, the Instruction Follower expresses her thanks, and the Instruction Giver uses the stylised form of the movement on the conventional reply *De rien* ‘You’re welcome’, which she apparently uses to enhance the impression that there is nothing to thank her for.
Stylisation of the falling movement to mid from the penultimate unaccented peak in *De rien. Au revoir. ‘You’re welcome. Goodbye.’*

Stylised contours were extremely rare in our corpora, and their analysis will not be incorporated in the present proposal.

5.2.6. Summary

The discussion of realisational differences in IP-final pitch movements has revealed that, in addition to the uncontroversial four-way distinction between rises, falls, rise-falls, and movements with a penultimate unaccented peak, variation in the pitch of the end of the movement may represent phonological distinctions. Thus, we distinguish two levels for the height of the peak in final rises (mid/high), and for the depth of the fall in final falls and in movements with a penultimate peak (mid/low). The direction of pitch in the onset of the movement and the timing of the dip and the peak were, on the best available evidence, concluded to be realisational variants. Although pitch direction in the onset was observed to depend on the context (e.g. whether or not the movement was preceded by a pitch accent in the same IP), it did not appear to reflect an intonational contrast. Similarly, the timing of the peak was found to be conditioned by the segmental structure of the syllable in rising-falling movements, representing ‘allophonic’ variation. No convincing evidence was found for distinctions due to timing in the other movements either.

5.3. IP-internal pitch movements

Most IP-internal pitch accents in the corpora were realised as overall rising-falling movements. That is, fundamental frequency rose towards a peak in the accented syllable, and fell towards the following accented syllable. In a number of cases, the IP-internal accented syllable was preceded by a fall instead of a rise (referred to as ‘falling movements’ in this section), and in a few cases, fundamental frequency was rising instead of falling after the accented syllable (referred to as ‘rising movements’).
The discussion of the realisation of IP-internal pitch movements in this section does not distinguish between word-initial and word-final pitch movements. The assumption of a phonological distinction has primarily been based on the difference in function between word-initial and word-final stress (e.g. rhythmic or emphatic for initial stress and demarcative for final stress). In the view adopted in this thesis, functional differences between intonation contours are not necessarily mirrored by structural differences, and therefore do not in themselves provide a sufficient basis for positing distinctions at the phonological level. This means that word-initial and word-final pitch movements would need to show a consistent formal difference for them to be phonologically distinct.

As it happens, there is a phonetic difference, since unlike word-final syllables, word-initial syllables which are marked by a change in pitch are not necessarily realised with increased amplitude or duration relative to the surrounding unstressed syllables (e.g. Séguinot 1977). There are two reasons why we think this observation should not be reflected in the tonal representation of the pitch movement. The description of intonation contours is primarily concerned with variations in pitch associated with stressed syllables, but as we have seen, the prominence of a syllable need not always arise from a change in pitch. Firstly, word-initial prominence can be conveyed by lengthening and/or increased amplitude alone, which could be interpreted to imply that the initial syllable can be stressed without being accented. Some metrical representation would be needed to account for this phenomenon. Secondly, the increase in duration and amplitude on the final syllable could also be accounted for on the basis of the immediately following constituent boundary (of the word, the PP or the IP), and thus be divorced from the concomitant phonetic effects.

Another formal argument can be made for a phonological distinction between word-initial and word-final pitch accents. Rises in word-initial accented syllables have been claimed to start earlier (in the onset consonant) than rises in word-final accented syllables, where the peak is located at the end of the vowel (Beaugendre 1994; cf. Vaissière 1975). Obviously, our data were not sufficiently controlled to allow for a systematic comparison of the pitch movements in word-initial and word-final position, but we found no evidence for a consistent difference. In Figure 26, some realisations of IP-internal word-initial and word-final pitch movements illustrate this point. We selected cases with similar segmental structures which occurred in a comparable position in the IP (i.e. they were always preceded by one or more pitch accents in the same IP).

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18 As it is used here, the term "word-initial" is intended to cover pitch movements that appear to be associated with the first or the second syllable of polysyllabic words (cf. Chapter 4).
Figure 26: Some realisations of pitch movements on word-initial and word-final syllables in the read speech corpus. The column on the left gives word-final and the one on the right word-initial pitch movements; the syllables in the first two columns were the first accented syllable in the IP, and those in the last two columns were preceded by one or more other pitch accents. The shaded areas correspond to the underlined syllables.

As can be seen in the figure, the peak of the rising-falling movements is early only when the syllable starts in a voiceless consonant, but this is true for both word-initial and word-final pitch movements (top row). No other differences are evident. Possibly, contextual factors explain the consistent difference in the timing of the peak reported in Beaugendre (1994). Word-initial pitch movements tend to occur
closer to the initial Intonation Phrase boundary than word-final movements, because the number of preceding syllables will be smaller, and this may result in consistent realisational differences. Also, an initial movement is much more likely to be the very first movement in the IP than a word-final movement, if only because speakers tend to produce 'accentual arcs' to mark the beginning and the end of a Phonological Phrase (cf. Chapter 4). On this basis, we assume that the difference between word-initial and word-final accents should not be accounted for in the intonation system (cf. Chapter 6 section 6.4).

The following subsections discuss the observed variation in overall rising, rising-falling and falling movements, respectively. The findings for the IP-internal movements are summarised in Section 5.3.4.

5.3.1. Rising movements

IP-internal movements in which the accented syllable was located on a rising slope up to a following pitch accent were rare in the corpora. Figure 27 gives an example in which speaker SB produces two such rises at the beginning of the utterance. Fundamental frequency appears to be rising in all accented syllables (the dip at the location of the /d/ is not audible).

![Figure 27](image)

**Figure 27:** IP-internal rising movements in *Voulez-vous danser cette valse* ... 'Would you like to dance this waltz ...' The syllables in question are marked by a grey box; grey shading indicates the other accented syllables in the phrase. (The other speakers produce rising-falling or falling movements).

To our knowledge, only rising movements in which pitch continues at the same level before falling in the following accented syllable have been described in the literature (Vaissière 1974, 1975; Jun and Fougeron 1995).

5.3.2. Rising-falling movements

Like IP-final rising and rising-falling movements, IP-internal rising-falling movements appear to start from the IP boundary or just before the accented syllable
when there are no preceding pitch accents, as the realisations of *Cendrillon* in Figure 28 illustrate.

Figure 28: IP-initial and medial rising-falling movements in *Cendrillon lui avoue tous ses malheurs* 'Cendrillon tells her of all her troubles'. The grey box indicates the syllable in question; the other accented syllables are shaded (only syllables that are accented by all four speakers are underlined in the phonetic transcription).

A comparison between the examples in the figure and those in Figure 29 shows that the dip before the rising part of the movement can be located in or just before the accented syllable.

This is a characteristic the IP-internal rising-falling movement shares with the IP-final rising movement. As mentioned in Section 5.2.2, Mertens (1986, 1987) posits that the two variants are phonologically distinct. However, Jun and Fougeron (to appear) have shown that the location of the dip in IP-internal word-final rises is sensitive to the number of syllables that precede the rise. This finding suggests that the timing of the low point is not in fact contrastive. We therefore

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19 As Mertens does not distinguish between IP-internal and IP-final pitch movements (both are transcribed as sequences of two tones), his claim also applies to the pitch movements described here.
assume that the difference depends on the rhythmic and, possibly, segmental structure of the utterance, as in the IP-final rises.

![Figure 29: Early and late timings of the dip in ... *les mots de sa marraine* '...her godmother's words' (speakers CG and SB versus FD and CO, respectively). The shaded box marks the syllable in question (*mots*).](image)

Figure 28 also shows that the location of the peak in the accented syllable is conditioned in the same way as in IP-final rising-falling movements. In *tous*, it is consistently located at the beginning of the accented syllable. The remainder of the syllable is pronounced at the same level (speaker CG) or is falling (the other speakers). This appears to be the case whenever the onset of the syllable is voiceless. When the syllable is voiced throughout, the peak is usually realised at the end of the vowel, as the realisation of -lon and -voie (Figure 28) and that of *mots* (Figure 29) illustrate. These observations are in line with Beaugendre's findings that the timing of the peak depends on the segmental structure of the syllable, and that early and late timings are perceptually equivalent (1994:90-93). However, our data revealed a third realisation, in which the peak appeared to be delayed beyond the first accented syllable, as is shown in Figure 30.
Figure 30: A delayed peak in *Voulez-vous danser*... ‘Would you like to dance’ (speaker FD).

Despite the huge pitch excursion on *-lez*, it is the syllable at the start of the rising movement (i.e. *vou*) that sounds more prominent. The peak is followed by a steep fall onto the next accented syllable *vous*. The impression this speaker’s realisation gives is one of an extremely polite request. A similar phenomenon can be found in English, where delayed tones are often used to signal non-routineness (Gussenhoven 1984). However, such realisations were extremely rare in our corpus, and we have failed to find references to the phenomenon in French. Therefore, we have to conclude that it cannot play a very substantial role in the intonational phonology of French.

Unsurprisingly, the pitch falls in the syllables that follow the accented syllable, with the steepness of this fall depending on the number of unstressed syllables, which is exemplified in Figure 31 (cf. Post 1993; Jun and Fougeron 1995, to appear). Speaker CO produces a steep fall between the accented syllables *-rive* and *mai*—, which are separated by two unstressed syllables, whereas FD produces a shallower fall between *-rive* and *-son*, which are separated by three unstressed syllables. These examples clearly show that in French, pitch is interpolated between tonal targets that are associated with accented syllables, and that the syllables intervening between them can be left phonologically unspecified for tone, as in languages with dynamic stress such as English, and languages with lexically specified pitch accents such as Japanese (Pierrehumbert and Beckman 1988:34ff).

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20 Also, Wichmann et al. (1997) found that in utterances which introduced a new topic in the discourse, the peak of the first pitch accent could be realised after the accented syllable.
Figure 31: IP-internal rising-falling movements in which the steepness of the fall depends on the number of unstressed syllables that follow the accented syllable in Quand il arrive à la maison de Cendrillon ‘When he arrives at Cendrillon’s house’.

The size of the pitch excursion appears to be primarily conditioned by the hierarchical relations between the constituents in the utterance. That is, IP-internal pitch movements tend to have smaller ranges than IP-final movements, and the size of the excursion of IP-internal movements relative to each other has been claimed to reflect syntactic constituency (Delattre 1966; Martin 1975a; Di Cristo 1976; Rossi 1981, 1985; Mertens 1992; cf. Chapter 2 section 2.1.3). Thus, pitch excursion can be used to disambiguate utterances, as the classical example taken from Delattre (1966) in Figure 32 illustrates.

Figure 32: Disambiguation of J’ai vendu ma maison en Espagne ‘I sold my house in Spain’ by means of the relative range of the pitch movements: (a) the house is in Spain (left), and (b) the sale took place in Spain (right).
However, when a speaker wants to emphasise a particular word, he may upset these structural relations. In our view, such IP-internal differences in pitch prominence should not be accounted for in terms of distinct intonational categories.\textsuperscript{21}

5.3.3. Falling movements

In the read speech corpus, falling pitch movements also occurred IP-internally. Figure 33 gives some examples of such falling movements. Fundamental frequency on the stretch of unstressed syllables before the accented syllable is falling or level (speaker SB also produces a level stretch, but steps slightly up to the accented syllable -yer).\textsuperscript{22}

The figure also shows that fundamental frequency can be level (or slightly rising) in the accented syllable itself, but it can also be falling, as in CO’s realisation of -toufle. Furthermore, an inspection of all IP-internal falling movements in the corpora showed that, as in the examples of Figure 33, the accented syllable was never pronounced at the bottom of the speaking range, nor was it ever immediately followed by rising pitch. Instead, pitch continued to fall slightly or remained level. This means that we found no evidence for the IP-internal fall described by Coustenoble and Armstrong (1934), Martin (1975a, 1975b) and Crompton (1978) in which the accented syllable functions as the low turning point of the movement. Several studies support our conclusion that there is no category of IP-internal falling movements to low in French. Thus, Therrien-Roy et al. (1979) showed that Martin’s non-final falling movements C2 and C4 are in fact transitions between two rising movements on accented syllables. In a comparative investigation of non-final rising and falling movements in Dutch, Swedish and French, Beaugendre et al. (1997) found that their subjects were unable to identify an accented syllable in five-syllable reiterant utterances with an overall falling movement in which pitch falls suddenly in the third or fourth syllable. On this basis, they conclude that falling movements are not accent-lending in French.

This raises the question whether the IP-internal falling movements to mid in Figure 33 can be assumed to represent pitch accents. Auditory, the falling movements sound like a series of downward steps onto accented syllables. That is, the word-final syllables in question do sound more prominent than the surrounding syllables. This phenomenon has been analysed as downstep, where high pitch accents are lowered by rule (Di Cristo and Hirst 1984, 1995), which implies that IP-internal falling and rising(-falling) movements are considered to be phonologically

\textsuperscript{21} More precisely, in our view, Delattre’s distinction between continuation majeure and continuation mineure has to refer either to (a) the distinction between IP-final rises to high (Cmaj) versus mid (Cmin) (analysed as H*H% versus H*0% in Chapter 6), or to (b) the distinction between a IP-final rising movement and an IP-internal rising-falling movement (analysed as H*H% or H*0% versus H*). IP-internal distinctions between rising-falling movements do not exist.

\textsuperscript{22} The apparently higher F0 at the onset of voicing in -ayer in CO’s realisation is caused by consonantal perturbation of the preceding /s/; it is not audible. The auditory impression of speaker CG’s realisation is that of sustained level pitch after the first accent on -ve followed by a step down onto -yer.
distinct. However, this analysis may be interpreted to conflict with the findings of Therrien-Roy et al. (1979) and Beaugendre et al. (1997) reported above. Alternatively, one could assume that all syllables in an IP-internal falling movement are deaccented. In this case, the apparent greater prominence of the word-final syllables could only be attributed to the fact that they occur at some prosodic constituent boundary (e.g. at the level of the word or the Phonological Phrase), which results in final lengthening. However, there are no obvious arguments for a deaccentuation analysis in contours like that given in Figure 33. That is, the syllables -yer and -toufle do not belong to dislocated constituents, none of the information has been mentioned earlier, and there are no reasons to assume that the utterance has early narrow focus. Therefore, we will assume that the syllables are in fact accented.

Figure 33: IP-internal falling movements preceded by falling pitch (CO and FD before yer), or level pitch (CO and FD before toufle) in ...vez essayer cette pantoufle de verre ‘...come and try this crystal shoe’. A grey box marks the accented syllables in question.

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23 Downstep was originally proposed to account for the systematic lowering of sequences of high tones in African tone languages (see Van der Hulst and Snider 1993 for an overview), and was subsequently applied to American English for movements that are very similar to the ones discussed here (Pierrehumbert 1980).
5.3.4. Summary

The investigation of IP-internal pitch movements in the corpora revealed a three-way distinction between overall rising, rising-falling and falling movements around the accented syllable. Although the motivation for a category of IP-internal falling pitch accents is weakened by findings that suggest that IP-internal falling movements are not accent-lending, we assume that French has a contour similar to English, German and Dutch, in which IP-internal pitch accents are systematically lowered. For lack of evidence, a realisation in which the peak was apparently delayed beyond the accented syllable is not distinguished at the phonological level.

5.4. Conclusion

The description of the observed variation in pitch movements in two speech corpora reported in this chapter served to identify the differences that are phonologically relevant to the French intonation system. Figure 34 sums up the movements that were associated with accented syllables in the speech corpora. Phonological contrasts are represented in the first column, most of the observed variants of these categories are given in the second column, and the factors that were suggested to play a role are listed in the third column.

The figure shows that the traditional four-way distinction between IP-final pitch movements made in the literature was reflected in our data. In addition, we assume a two-way distinction on the basis of the pitch level reached at the end of the IP-final movement for rises, for falls and for movements with a penultimate unaccented peak. No convincing evidence was found for distinctions due to timing or to the direction of pitch in the onset of the movements.

Figure 34 also incorporates the three IP-internal pitch movements that were identified in the corpora. A rising movement towards a peak in the accented syllable could be followed by level or rising pitch (‘rising movement’) or by falling pitch until the following accented syllable (‘rising-falling movement’). These movements are assumed to contrast with movements in which the accented syllable is located on an overall falling slope (‘falling movement’; pitch can be level or falling on the unaccented stretches). This analysis of IP-internal movements differentiates between rising and falling movements in the same way as the description proposed by Di Cristo and Hirst (1984, 1995), and the distinction between rising and rising-falling movements is similar to that in Jun and Bougeron’s proposal (1995, to appear). However, the analysis also diverges from these descriptions in some important respects. The phonological analysis of the pitch movements in terms of tonal specifications will be discussed in the following chapter.
### IP-final

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<tr>
<th>Phonological contrasts</th>
<th>Observed variants</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rising to high</td>
<td></td>
<td>onset</td>
</tr>
<tr>
<td>2. Rising to mid</td>
<td></td>
<td>peak &amp; dip timing</td>
</tr>
<tr>
<td>(Presumably as in 1, but no systematic data available at this point)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Rising-falling</td>
<td></td>
<td>onset</td>
</tr>
<tr>
<td>4. Falling to low</td>
<td></td>
<td>timing lowest point</td>
</tr>
<tr>
<td>5. Falling to mid</td>
<td>(As in 4)</td>
<td></td>
</tr>
<tr>
<td>6. Fall from penultimate peak to low</td>
<td></td>
<td>timing lowest point</td>
</tr>
<tr>
<td>7. Fall from penultimate peak to mid</td>
<td></td>
<td>(As in 6)</td>
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</table>

### IP-internal

<table>
<thead>
<tr>
<th>Phonological contrasts</th>
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<th>Factors</th>
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<td>2. Rising-falling</td>
<td></td>
<td>peak &amp; dip timing</td>
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<tr>
<td>3. Falling</td>
<td></td>
<td>onset</td>
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Figure 34: Overview of the pitch movements found in the speech corpora.
Chapter 6  An Autosegmental-Metrical analysis of the intonation contours

6.1. Introduction

The intonation contours that have been identified are analysed in an Autosegmental-Metrical framework in this chapter. In accordance with other Autosegmental-Metrical analyses of French, we assume that at the underlying level, French tunes consist of sequences of Low and High tones (Hirst and Di Cristo 1984; Post 1993; Di Cristo and Hirst 1996; Jun and Fougeron, 1995, to appear; Di Cristo et al. to appear).1 Boundary tones mark the prosodic constituent at the highest level relevant to intonation (Intonation Phrase or Intonation Unit), and accented positions in the utterance are marked by pitch accents, in which the high tone is associated with the accented syllable.

Thus, the analyses agree that the French tune is best analysed as a sequence of underlying tones that associate with stressed syllables and prosodic boundaries. That is, tunes are not holistic units, nor do they have an internal structure in which nuclear accents are formally different from prenuclear accents (or ‘heads’).2 In principle, all combinations of the tones of the inventory are allowed, but their position relative to each other in the Intonation Phrase restricts the number of contours that can be generated. Moreover, the analyses agree that French has deaccentuation, as is illustrated in Figure 1. Both utterances are realised with a final falling movement from the accented syllable dé-, but déduction in (a) has another accent on its final syllable, and déduction in (b) does not. DE- in (b) is said to have a focal accent because the syllable is contrasted with the syllable RE-. In cases such as (b), where the focal accent occurs early in the utterance, the post-focal stretch is often deaccented and realised with low level or slightly falling pitch (e.g. Di Cristo 1998; Jun and Fougeron to appear).3 Thus, although the pitch movements are phonetically very similar, they are assumed to be phonologically distinct.

1 Although Mertens also decomposes intonation contours into strings of tones associated with the segmental structure, it is not included in the present discussion because it diverges from the autosegmental-metrical approach in some crucial respects (Mertens 1986, 1987, 1992; discussed in Chapter 2 section 2.1.3). Di Cristo and Hirst’s description is not Autosegmental-Metrical in the strict sense either. The major difference is that tones only associate with domains (the Tonal Unit and the Intonation Unit, which is similar to the Intonation Phrase), and not with stressed syllables (discussed in Section 6.4.2).

2 For convenience, the final accent of the IP could be referred to as the ‘nuclear accent’, as in Pierrehumbert (1980), but to avoid confusion the term will not be used here.

3 Deaccentuation of the post-focal stretch does not appear to be obligatory in French (Di Cristo and Jankowski 1999).
a. Final syllable accented:  
\[ \text{C'est une déduction} \]

b. Deaccentuation:  
\[ \text{J'ai dit \textit{REduction}, pas \textit{DEduction}} \]

**Figure 1:** Deaccentuation of the final syllable of *déduction* in *J'ai dit \textit{REduction}, pas \textit{DEduction}*. 'I said reduction, not deduction' ('T' stands for tone, '*' marks the pitch accent, and '%' the boundary tone).

As the figure shows, the incorporation of pitch accent and boundary specifications as separate elements in the phonological description naturally accounts for this situation (i.e. there is only a boundary tone in the deaccented case). In other words, we agree with the authors mentioned above that the distinction should be expressed as a difference in their tonal specification.

However, the descriptions also disagree on a number of fundamental points, which will be discussed in the final section of this chapter. The first point of disagreement concerns the levels of representation that are assumed to be relevant to the analysis of French intonation contours. Unlike the other accounts, we distinguish two levels: (a) the phonological level, at which the phonological tones are associated with the ‘text’, and (b) the phonetic level, at which the tonal string is interpreted in terms of fundamental frequency and time alignment. The second point concerns the association between the tonal and segmental structures, which we account for by means of a two-layered prosodic structure. The Intonation Phrase is marked by a boundary tone on either side, and it contains at least one Phonological Phrase, which has a pitch accent in phrase-final position. Finally, the descriptions disagree about the primitives of the tonal structure. That is, they have different inventories of pitch accents and boundary tones. In the present proposal, categorical distinctions are attributed to the interaction between (H+)H* pitch accents, boundary tones (L or H), and the presence of an additional low tone between pitch accents (L-insertion). The generation of discrete contours in IP-internal position is naturally constrained by the absence of an immediately following boundary specification.

In this chapter, our Autosegmental-Metrical analysis will be presented first (Section 6.2). Section 6.3 aims to show that the logically possible alternatives to our tonal specification should be rejected. The chapter concludes with a discussion of the advantages of this analysis over competing Autosegmental-Metrical descriptions (Section 6.4). It will be argued that they fail to generate some of the phonological contrasts, whereas not all of the predicted differences in fact represent categorical distinctions. Also, the tonal structure of the intonation contours of these descriptions is sometimes unnecessarily complex. The present account is more parsimonious, while making the correct predictions.
6.2. The tonal analysis

This section begins with a brief outline of our proposal. Next, the analysis is shown to account for all of the pitch movements discussed in Chapter 5. The way in which the intonational contrasts are phonologically specified is detailed, and a phonetic implementation rule that captures the observed variation in the realisation of the underlying categories is presented. A summary and the predictions of the account conclude the section.

6.2.1. Outline of the system

In the present proposal, French intonation is analysed by means of the pitch accent specification H* with an optional leading H, three boundary specifications, and an optional L-tone, as listed in Figure 2.

![Figure 2: The phonological specifications of the analysis.](image)

Any accented syllable has an underlying high starred tone, transcribed as H*. H* can be preceded by a leading H-tone, resulting in a bitonal H+H* pitch accent. The Intonation Phrase boundary can be specified as high (%H/H%), low (%L/L%) or it is not specified for tone (0%; the '0' symbol does not represent a tonal category, but is used as a boundary marker). The zero boundary specification was proposed by Grabe (1998a) to account for nuclear rises and falls in which pitch stays level after the accented syllable in German and British English. The third important feature of the analysis is L-insertion, by which a low tone is inserted between two high starred tones at the phonological surface level. The presence of this low tone is morphologically determined. That is, the speaker chooses to realise a low tone, and thereby modifies the interpretation of the pitch accent. L-insertion leads to a more explicit separation of the items marked by the starred tone. The low tone is usually aligned with the pre-accentual syllable, which results in a contour that is very similar to the one described by Gussenhoven (1984) for Dutch and British English as partial

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4 It is beyond the scope of this study to provide a detailed account of the various ways in which the phonological categories can be phonetically realised.
linking. When the low tone is not inserted, the items form a conceptual unity (cf. Gussenhoven 1984:246-248).

The tonal specifications can be combined within the Intonation Phrase according to the grammar given in (1).

\[
\begin{cases}
\%L \\
\%H
\end{cases}
\begin{cases}
(H^* (L))_b \\
H + H^*
\end{cases}
\begin{cases}
L% \\
H% \\
0%
\end{cases}
\]

In (1), parentheses indicate optional elements and curly brackets contain the set of tones available in the given position. The Intonation Phrase is marked by a boundary tone on either side, and speakers have a choice between low and high for both boundaries, but the final boundary can also be left unspecified for tone.\(^5\) The initial boundary tone can be followed by any number of IP-internal H* pitch accents.\(^6\) The H* tone can associate with word-initial and word-final syllables, their distribution being conditioned in the way described in Chapter 4. The bracketing indicates that optional L-insertion can only take place after H*. Hence, sequences of inserted low tones are excluded. The final pitch accent in the Intonation Phrase, for which there is a choice between monotonal H* and bitonal H+H*, is to all intents and purposes obligatory.\(^7\)

6.2.2. Analysis of the phonologically contrasting pitch movements

The grammar given in (1) attributes the difference between IP-final rising and rising-falling movements to the choice of the boundary tone. As is illustrated in Figure 3, the final rise in the question *Marianne est venue?* has an H% boundary tone, and the

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5 In the data of Chapter 5, IPs usually started at a low pitch level, but in some cases, pitch was high on an unaccented initial syllable (high onset). Further research will have to show whether the initial boundary can also be left unspecified for tone.

6 H+H* cannot occur in IP-internal position. The rising-falling movement in which a peak occurred between two accented syllables could be interpreted as an instance of IP-internal H+H* (Chapter 5 section 5.3.2), but this contour is extremely rare. Moreover, there is no evidence for contours with a pre-accentual peak after an initial low boundary (i.e. %LH+H* ...).

7 It is generally assumed that Intonation Phrases have at least one pitch accent in French, although the accent is not necessarily realised on the final full syllable. That is, when the pitch accent occurs early, and remainder of the utterance is deaccented, the deaccented stretch is assumed to belong to same constituent as the preceding pitch accent. For instance, in Di Cristo and Hirst (1996) the deaccented part forms a *Segment d'UI* within the Intonation Unit, and in Jun and Fougeron (to appear), it is an Intermediate Phrase contained in an Intonation Phrase. When an IP boundary is realised after the focussed word in early focus cases (signalled by a pause), the IP containing the post-focal material shows the same tonal variation as a neutral sentence, according to Jun and Fougeron. However, the reporting clauses mentioned in Chapter 5 strongly suggest that accentless IPs are also possible in French (cf. Figure 20 Chapter 5). Here, the clause was invariably realised with a considerable pause on either side, and three speakers produced completely level low pitch throughout the clause. The auditory impression strongly favoured the view that they were in fact accentless.
exclamation *Marianne est venue!* has an L% boundary. In both cases, an H*-tone associates with the final syllable, which is preceded by an H* pitch accent on rianne.

**Figure 3:** The contrast between IP-final rising and rising-falling movements: H% versus L%.

This means that the movements are structurally similar in that they consist of the same pitch accent. The movements contrast with IP-final falls because of L-insertion, as shown in Figure 4. The crucial point about L-insertion is that, when there is no low tone intervening between two high targets, the latter target is automatically lowered. That is, the high starred tone is implemented phonetically as a downstepped high tone when it immediately follows another high tone in the same Intonation Phrase (top left in Figure 4). Thus, an HH-sequence surfaces as a fall. Figure 4 also shows that downstep is blocked when the HH-sequence is followed by a high boundary tone, even though L-insertion has not applied (bottom left).

**Figure 4:** The contrast between IP-final rising(-falling) and falling movements: L-insertion and L%.
The boundary specification also distinguishes falling movements to the bottom of the fundamental frequency range from falls to mid, as can be seen in Figure 5.

![Graph showing the contrast between falls to low and falls to mid.](image)

**Figure 5:** The contrast between falls to low and falls to mid: L% versus 0%.

In both falling movements, H* immediately follows a high tone, and is therefore implemented as a downstepped pitch accent. In the fall to low, H* is realised at the bottom of the fundamental frequency range, as it is immediately followed by a low boundary specification. When the boundary is not specified for tone, the falling movement stops in the middle of the range. Thus, IP-final falling movements to mid mirror those which occur in IP-internal position, as can be seen in Figure 6. Analogous to the IP-final fall to mid, this lowered H* is not realised at the bottom of the fundamental frequency range when it is not immediately followed by L%.

![Graph showing identical tonal specifications for falling movements to mid.](image)

**Figure 6:** Identical tonal specifications for falling movements to mid in IP-final and IP-internal position.

In a series of IP-internal pitch accents without L-insertion, the tonal specification is normally realised as the stepwise lowering of pitch from one accented syllable to another, but it is not obligatory, as the existence of IP-internal rising contours shows (cf. bottom realisation in Figure 7). In the latter case, the last H-tone is followed by H%, and downstep is blocked. The level realisation of the syllables preceding the pitch accents exemplified in Figure 7 is optional, and could be accounted for by spreading of the high tone. Spreading is a phonetic implementation rule which

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8 Downstep should not be confused with declination.
describes fundamental frequency that continues at the level of the preceding tonal target (Pierrehumbert 1980; Gussenhoven 1984).

![Figure 7: Variation in the onset of IP-internal falling and rising movements analysed as phonetic spreading on Tu sais que Marianne est venue 'You know that Marianne has come'.](image)

The distinction between Intonation Phrase boundaries that are specified for tone and those that are not also accounts for the phonological contrast between IP-final rising and high rising movements in this model. In Figure 8, a rise in the continuation context C'était Marianne,... 'It was Marianne,...' is contrasted with a higher rise in the question context C'était Marianne? The high boundary tone reinforces the upward movement caused by the preceding high tone, similar to the phonetic implementation effect 'upstep' described for American English by Pierrehumbert (1980).

![Figure 8: The contrast between IP-final rising movements to high and to mid: H% versus 0%.](image)
Thus, a similar difference in the phonological specification reflects a similar difference in the pitch level of the accented syllable in rising and falling movements.\(^9\)

The boundary specification also accounts for the difference in pitch level of movements with a peak on the penultimate (unaccented) syllable. The movement is transcribed as an H+H* pitch accent, where the leading high tone associates with the penultimate syllable, and the H* with the final accented syllable of the Intonation Phrase, shown in Figure 9 (alternative realisations with phonetic spreading of %L are also possible).\(^10\)

**Figure 9:** Analysis of the movements with a peak in the penultimate unaccented syllable.

When the boundary is low, as in (a), pitch goes down to the bottom of the range, and when it is unspecified for tone, as in (b), it remains at mid level. This analysis suggests that a third combination of pitch accent and boundary specification should also exist, viz. H+H* H%, for which no evidence has been provided so far. In this case, downstep of the starred tone is blocked by the following high boundary, which would be realised as a rising pitch movement such as (c). Evidently, the realisation given in Figure 9 (c) could also be analysed as %LH* H%. However, when the IP has more than one accent, the two tonal specifications would be predicted to have different surface forms, as is illustrated in Figure 10.

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\(^9\) This means that, as in Gussenhoven and Rietveld’s synthesis system for Dutch, the distinction between pitch accents that run their full course and those that stop at mid level is analysed as a difference in boundary specification (Gussenhoven and Rietveld 1992; cf. Grabe 1998a). The contrast will be discussed more extensively in Chapter 7.

\(^10\) For the fall to mid from a penultimate peak, Ladd (1996:140) suggests an analysis as L+H+!H*, where !H* is a downstepped high accent tone, and L and H leading tones (he adds that L may in fact belong to a preceding prenuclear accent, or that it is a left edge tone for the phrase). The L-tone spreads over all syllables before the penultimate one, the H-tone is associated with the penultimate syllable, and !H* with the final syllable (Ladd 1996:140-142 examples 4.36 and 4.42).
AN AM ANALYSIS OF THE INTONATION CONTOURS

Figure 10: $H^*H\%$ versus $H+H^*H\%$.

The figure shows that the L-tone should be aligned later in $LH^*H\%$ (a) than in $LH+H^*H\%$ (b). In fact, some early rises were observed in the corpora, one of which is given in Figure 11 (from the read speech corpus).

![Figure 11: IP-final rising pitch from the antepenultimate syllable in ...ébloui par sa beauté... ‘...dazzled by her beauty...’.

An experimental study by Auteserre and Di Cristo (1972) strongly suggests that the relative height of the penultimate syllable in the final rise plays a role in distinguishing between questions and continuations. Di Cristo describes the contour in Figure 13 as Upstep High, and it contrasts with LH or DH (Downstep High), in which the penultimate syllable is lower than the antepenultimate syllable (Di Cristo and Hirst 1996). Mertens’ analysis (1986, 1987) also describes a sequence of a high pre-accentual tone followed by a high tone on the accented syllable, although he states that it is normally followed by a lower tone (l...hHH or l...hLL, here analysed as $H+H^*0\%$ and $H+H^*L\%$, respectively). According to Mertens, the morpheme l...h signals detachment on the part of the speaker, who presents his words as if they were somebody else’s. The specific interpretation of the morpheme l...h depends on the tones of the following accented syllable, and on the lexical material it is combined with. The present analysis also allows us to capture this similarity in meaning as a similarity in form.

6.2.3. Summary

Phonologically, the intonation contours of French are captured by an inventory of two pitch accents $H^*$ and $H+H^*$, an inter-accentual L, and five boundary
 specifications %L, %H, L%, H%, and 0%. At the phonetic level, H* tones that immediately follow a high tone are downstepped unless they are followed by H%. Optional spreading accounts for phonetic variants in which pitch continues at the level of the preceding tonal specification. The combinations of tones allowed by the grammar and their phonetic implementation are illustrated in Figure 12.

<table>
<thead>
<tr>
<th>Grammar:</th>
<th>Phonological representation</th>
<th>Phonetic implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>%L %H (H*(L)_0 {H* H+H*} L% H% 0%</td>
<td>IP-final:</td>
<td></td>
</tr>
<tr>
<td>1. %L H* L H* H% (rise to high)</td>
<td></td>
<td>spreading (optional)</td>
</tr>
<tr>
<td>2. %L H* L H* 0% (rise to mid)</td>
<td></td>
<td>spreading (optional)</td>
</tr>
<tr>
<td>3. %L H* L H* L% (rise-fall)</td>
<td></td>
<td>spreading (optional)</td>
</tr>
<tr>
<td>4. %L H* H* H% (rise-rise)</td>
<td></td>
<td>spreading (optional) (downstep blocked)</td>
</tr>
<tr>
<td>5. %L H* H* L% (fall to low)</td>
<td></td>
<td>downstep (obligatory) spreading (optional)</td>
</tr>
<tr>
<td>6. %L H* H* 0% (fall to mid)</td>
<td></td>
<td>downstep (obligatory) spreading (optional)</td>
</tr>
<tr>
<td>7. %L H* L H+H* H% (early rise)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. %L H* L H+H* 0% (fall to mid; pen. peak)</td>
<td></td>
<td>downstep (obligatory)</td>
</tr>
<tr>
<td>9. %L H* L H+H* L% (fall to low; pen. peak)</td>
<td></td>
<td>downstep (obligatory)</td>
</tr>
<tr>
<td>10. %L H* H+H* H% (rise-rise)</td>
<td></td>
<td>(same as 4)</td>
</tr>
<tr>
<td>11. %L H* H+H* L% (fall to low)</td>
<td></td>
<td>downstep (obligatory) spreading (optional)</td>
</tr>
<tr>
<td>12. %L H* H+H* 0% (fall to mid)</td>
<td></td>
<td>downstep (obligatory) spreading (optional)</td>
</tr>
<tr>
<td>IP-internal:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. %L H* L H* L H*... (rise-fall)</td>
<td></td>
<td>spreading (optional)</td>
</tr>
<tr>
<td>14. %L H* H* H*... (fall)</td>
<td></td>
<td>downstep (obligatory) spreading (optional)</td>
</tr>
<tr>
<td>15. %L H* H* H*...H% (rise)</td>
<td></td>
<td>downstep blocked spreading (optional)</td>
</tr>
</tbody>
</table>

Figure 12: Overview of the tonal specifications allowed by the grammar and their phonetic implementation (represented as stylised contours, illustrated on a two- or three-accent IP).
For the options in IP-final position, an Intonation Phrase with two pitch accents is given, and for the IP-internal options, three pitch accents are indicated. Not all possible phonetic variants of the phonological representations are listed, for instance, spreading can apply to all initial boundary tones, and of course other phonetic variation, like intrinsic pitch, has been abstracted away from. The low initial boundary tone in all phonological representations can be replaced with a high tone (the consequences of this move for the phonetic implementation will be discussed briefly below). In the top six representations of the figure, the final boundary specifications are varied while an L-tone is inserted between the H*-tones (representations 1-3), or is absent (representations 4-6). The same combinations are shown in representations 7 to 12, but here, the IP-final pitch accent is H+H* instead of H*. As can be seen, the difference between final H* and H+H* is neutralised in the absence of an inter-accentual L-tone (compare 4 and 10; cf. Figure 9 (c) above). Representations 13 to 15 illustrate the tonal structures allowed in IP-internal position with their phonetic implementations.

To a large extent, the explanatory power of the analysis resides in L-insertion and/or the boundary specification. Although rising and rising-falling movements are phonologically analysed as LH melodies, the L-tone is not part of the pitch accent specification. In IP-final position, the categorical distinctions related to the endpoint of the movement (high, mid and low) are captured by the boundary specification. Differences in timing, in the direction of pitch in the accented syllable or in the onset of the movement are accounted for at the phonetic level of representation. Thus, the tones of the underlying structure are not phonologically modified or deleted in this model.

6.2.4. Predictions

Given the grammar in (2) above, which specifies the tonal specifications that are associated with certain positions in the Intonation Phrase, the present proposal makes strong predictions about which intonation contours can be generated in French. That is, a sequence of, for instance, HL% is excluded in the system, because unstarrred H-tones only exist as the leading tone in the H+H* pitch accent. As a consequence, unstarrred H can never directly precede an IP-boundary specification. This means that the system can be tested. This section discusses some of those predictions.

As is shown in Figure 13, the automatic application of downstep after a high target excludes contours in which pitch is interpolated between two high targets without a following rise ('hat patterns', rising-level and level-falling realisations). The second high tone has to be downstepped, or the first high target has to be preceded by a rising or a low level onset (bottom right).
Another consequence of complementary L-insertion and downstep is that two immediately adjacent pitch accents in an Intonation Phrase, such as *Cendrillon lui avoue tous ses malheurs* (given as Figure 28 in Chapter 5), must be either H*LH* or H*H*. The prediction is that, since H* is automatically lowered after H*, the second pitch accent can only be equally high or higher than the first if the tonal specification is H*LH*. This implies that we expect the intonation contour to surface with a valley between the accentual peaks in such cases. In fact, *tous* indeed has higher pitch than *voue* in the realisations of two speakers, which means that the tonal specification must be H*LH*, but there is no evidence for the low target in these realisations. We assume that in this example, there is not enough room for the L-tone to be realised, because the segments intervening between the vowels are voiceless (cf. Jun and Fougeron 1995, to appear). Nevertheless, the contour has an underlying low tone, and as a consequence, the low target is predicted to surface when there is enough room (e.g. when the syllables are sonorant throughout).

Related to this issue is the confusion that might arise about the phonological identity of movements in which a peak in the penultimate syllable is followed by a fall to low. That is, their phonological representation can be H+H*L% or H*H*L%, depending on whether the penultimate syllable is accented syllable or not. Although we did not observe any unambiguous instances of H*H*L% on two adjacent syllables in our corpora, and we believe that immediately adjacent pitch accents do not occur within the Phonological Phrase in 'neutral' speech (cf. Chapters 3 and 4), some cases have been reported in the literature (Santerre 1990; Mertens 1992). According to Mertens, two pitch accents can be realised adjacenttly, on condition that one of them is produced with high, and the other with low pitch (as is

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11 The same applies to movements with a fall to mid from a penultimate peak (H+H*0% or H*H*0%).
the case in H*H*L% at issue here). The non-final accented syllable often shows an increase in duration, or is followed by a pause (Mertens 1992:161). Thus, if the penultimate syllable is marked by a change in pitch, by lengthening and by an increase in amplitude, we can safely assume that the correct representation is H*H*L%. However, word-initial pitch accents are not necessarily realised by an increase in duration and intensity as well as a change in pitch (cf. Chapter 5 section 5.3 and Section 6.4 below). As a consequence, realisations of utterances such as C'est joli 'It's pretty' with a peak on jo- and a fall on -li, could still be either H+H*L% or H*H*L%.

As we have seen above, the incorporation of bitonal H+H* in the system implies that the pitch accent can be combined with the three boundary specifications H%, L% and 0% (cf. representations 7 to 9 in Figure 12). This analysis predicts that in movements in which the penultimate peak is followed by lower pitch (H+H*L% or H+H*0%), only the perceived pitch level in the final syllable is distinctive (mid or low); the direction of pitch is irrelevant. For instance, a realisation in which pitch falls onto the final syllable and then rises slightly towards the end is a phonetic variant of a realisation in which pitch continues at the same level. This prediction conflicts with Jun and Fougeron (to appear), who distinguish H*L-H%, realised as a peak on the penultimate and a fall-rise on the final syllable ('incredible cliché'), from H*H-L%, realised as a rise on the penultimate syllable and mid level pitch on the final syllable (used for lists, vocatives and 'implication'). Thus, the tones of H*L-H% are assumed to reflect phonetic targets, but in H*H-L%, H* is one target, while the combination of H-L% is another, realised as mid level pitch. However, in the pitch traces of the examples they provide for H*H-L%, pitch sometimes rises towards the end of the syllable as well, which seems incongruous with the transcriptions proposed. In our view, both are variants of H+H*0%. Phonetic realisations in which pitch rises towards the end of the syllable (which is not necessarily perceptually salient) are used to reinforce the auditory impression that pitch is not low in the final syllable.

Our analysis also makes predictions about the intonation contours that can surface in cases of deaccentuation (e.g. due to early focus; Di Cristo 1998; Jun and Fougeron to appear). Figure 14 illustrates the three possibilities resulting from the combination of H* and a boundary specification, implemented as rising, level or falling pitch from the accented syllable to the end of the utterance. Possible interpretations are given for each category, and the dotted lines indicate some phonetic variants.

---

12 Helsloot (1995) describes a similar tonal configuration in Italian as 'Pitch Jumping'. She claims that the target fundamental frequency values of the two immediately adjacent pitch accents are realised as either a rising or a falling jump as a consequence of the Obligatory Contour Principle. Accordingly, we assume that the Obligatory Contour Principle prohibits immediately adjacent identical realisations of pitch accents within the Phonological Phrase in French.

13 Though less likely, H+H*L% may be used in the contexts mentioned as well. In those cases, the fall will have to reach the bottom of the speaking range.
Context
Speaker A says: Jean-Marie est venu.

Speaker B thinks he understood 'Jean-Paul' and checks this

Speaker B thinks he understood 'Jean-Paul' and establishes this as a fact

Speaker B corrects speaker A

Speaker B answers: Jean-Paul est venu

Figure 14: Predicted three-way distinction between falling, level and rising pitch on post-accentual syllables.

This analysis conflicts with that of Delattre (1966b:12-13), who claims that such stretches are always level (parenthèse). After a rise, pitch continues at a high level, and after a fall, it is low, but both are instances of the same 'intoneme' (i.e. they are not phonologically distinct). However, Wunderli (1987) has shown that the predicted contours of Figure 14 do actually occur, and Jun and Fougeron (to appear) elicited contours with early focus in which the H-tone of the pitch accent was followed by more or less level pitch and a final rise (given as the dotted line at the top in Figure 14).

6.3. Alternative tonal specifications

The previous section has shown that (1) the present analysis makes clear predictions about the grammatical status of differences in pitch movements - phonetic or phonological, and (2) it does not generate any contours that have not been attested. Nevertheless, alternative analyses might be equally successful in accounting for the data. The aim of this section is to show this not to be the case. The arguments for the specifications of rising and rising-falling movements will be presented first, followed by a discussion of the analysis of falling movements and movements with a fall from a pre-accentual peak.

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14 Delattre refers to the global form of the intonation contour alone; the location of the accented syllables is not specified.)
6.3.1. Rising and rising-falling movements

Figure 15 shows that a low target followed by a high target need to be accounted for in rising as well as rising-falling pitch movements, and that the latter need an additional specification for the final low target (left column).

<table>
<thead>
<tr>
<th>Targets</th>
<th>Possible alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>L H (L)</td>
<td>1. L H (L) 2. L H (L) 3. L H (L) 4. L H (L) 5. L H (L)</td>
</tr>
<tr>
<td>Rising</td>
<td>%L H* H/0% ...L+H* H/0% ...L*+H H/0% ... H* H/0% ... H* H/0%</td>
</tr>
<tr>
<td>Rising-falling</td>
<td>%L H* L% ...L+H* L% ...L*+H L% ... H* L% ...H+ L* L%</td>
</tr>
<tr>
<td>Rising-falling</td>
<td>%L H* ... ...L+H* ... ...L*+H ... ... H*+ L ... ... H* ...</td>
</tr>
</tbody>
</table>

Figure 15: The targets in rising and rising-falling movements and their alternative specifications.

In the present analysis, both types of movements are represented by the same pitch accent H*. This means that the pitch accent is assumed to be monotonal, not bitonal, and that the starred tone of the pitch accent is a high tone. The final low target is attributed to a low boundary tone. There are five alternatives to this analysis, which are also given in Figure 15:

I. an H* tone is preceded by an initial low boundary tone (%LH*),
II. an H* tone is preceded by a low leading tone (L+H*),
III. an L* tone is followed by a high trailing tone (L*+H),
IV. an H* tone is preceded by a low trailing tone of a different pitch accent (H*+L H*); IP-final and IP-internal movements have different pitch accent specifications,
V. IP-final rising-falling movements have an L* tone as their final low target (H+L*); IP-internal rising-falling movements and IP-final rises have a different pitch accent specification H* and boundaries can be 0% or H% only.

These alternative accounts will be discussed in the remainder of this subsection.

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15 Monotonal L* (H%) for IP-final rises cannot straightforwardly account for the height distinction in rises and is therefore not discussed here.
6.3.1.1. %LH*
An analysis in which the first low target of all rising(-falling) pitch movements is an initial boundary tone has to be rejected because, evidently, it cannot account for Intonation Phrases with more than one pitch peak, as is illustrated in Figure 16. Final rises would be predicted to always rise from a preceding peak, and words with an initial and a final pitch accent, like Marie-Claire, cannot have an intervening low target (hat pattern). Therefore, in addition to the initial low boundary tone, a specification for non-initial low targets needs to be incorporated in the grammar.

![Figure 16: Comparison of the analyses as %LH* and H* with L-insertion.](image)

6.3.1.2. L+H*
An obvious competitor for monotonal H* with L-insertion is bitonal L+H*, whereby the low target that precedes the movements specified in the pitch accent. Three arguments can be raised against this solution. First, a phonologically different choice is made for some variants of the onset of rising and rising-falling movements. In Figure 17, the three variants of the IP-final rising movement are given to illustrate this point. In (a), the pitch rises from the beginning of the Intonation Phrase (‘gradual rise’), in (b), the pitch remains low until the rise in the final syllable(s) (‘steep rise’), and in (c), the IP-final movement is preceded by an IP-internal pitch accent.
Figure 17: The analysis as L+H* implies a different choice from the phonological inventory for gradual and steep rising movements.

As the figure shows, an analysis with L+H* can only account for the gradual rises in (a) by adopting either a separate pitch accent category H*, or a deletion rule for the leading L. Thus, it needs to make a categorical distinction between ‘gradual’ and ‘steep’ rises, but since there is no evidence for such a distinction, this solution needs to be rejected.

The second argument against L+H* is that it makes the analysis of IP-internal falling movements unnecessarily complex. More precisely, a fall could only be arrived at when the low leading tone is deleted, and the starred tone downstepped (i.e. L+H* L+H*... becomes L+H* H*... with lowering of the second H-tone). In order to avoid the stipulation of a phonological deletion rule, a separate category H* could be adopted for all IP-internal pitch accents, but in that case, the analogy with IP-final pitch accents is lost. Alternatively, (H+)L* could be adopted for IP-internal falling movements (rising and rising-falling movements would still be L+H*), but this has the drawback that some phonetic realisation rule has to ensure that L* is not implemented at the bottom of the fundamental frequency range in IP-internal position, since the accented syllable is located on a falling slope, and not at the end of the falling movement. Also, the inclusion of an additional pitch accent in the inventory makes the account is less economical than the present one.

Third, the analysis cannot exclude realisations in which a high onset is followed by a rising or a rising-falling movement, which forms are unattested in French. This is shown in Figure 18.

Figure 18: Problematic predictions of the L+H* analysis.

6.3.1.3. L*+H
The third alternative is to analyse all movements as L*+H. The analysis captures the fact that it is usually the low target that functions as the turning point in the movement, as shown in Figure 19.
Yet, the analysis makes two problematic predictions. Although the low target is often realised in the accented syllable in IP-final rising and IP-internal rising-falling movements, as in Figure 20 (a), it can also occur in the penultimate syllable, as in (b). In the IP-final rise-fall, the first low target is never realised within the accented syllable, whereas the peak invariably is.\textsuperscript{16} A rule would have to be adopted which allows the starred target to be realised before the accented syllable, which is obligatory in IP-final rising-falling movements, but optional in IP-internal rising-falling and IP-final rising movements. This situation seems incongruous with an analysis in which the low starting point is represented as a starred tone. Analysing the high target as the starred tone seems more viable.

The second problematic prediction is that the onsets given in Figure 20 (a) and (b) are categorically different from those in (c).

\textsuperscript{16} This is clearly visible in IPs in which the last accent is followed by an unaccented stretch or a schwa (see examples in Figure 23 below).
Figure 20: Problematic predictions of the L*+H analysis.

As was pointed out in the discussion of L+H* above, there is no evidence for such a distinction.

6.3.1.4. H*+L H*

The fourth analysis attributes the low target to a preceding pitch accent H*+L, which makes essentially the same predictions as the analysis proposed here. Figure 21 shows that high onsets followed by a rising or a rising-falling movement (a) cannot be generated, and hat pattern realisations as in (b) are excluded because the preceding pitch accent projects a low target before the final accented syllable (when this trailing L is deleted, the following H* is downstepped in this context). Instead of inserting a low tone in the contours of (c), a deletion rule would account for the variants in (d). Thus, the contour in (c) has the default specification in this description, which could in fact be interpreted as an advantage.\(^{17}\)

\(^{17}\) As in the present proposal, spreading of the initial boundary tone could account for movements with a level onset.
Figure 21: Comparison of the analyses as preceding \(H^*+L\) with deletion and \(H^*\) with L-insertion.

Nevertheless, the \(H^*\) analysis with L-insertion is preferred here, because in the alternative with \(H^*+L\), the L often needs to be deleted, which involves more cumbersome stipulations. As can be seen in Figure 22, deletion would have to be assumed to be optional before \(H^*\), as in examples (a) and (b), but obligatory before \(H%\), as in (c). By comparison, L-insertion is straightforward: it is always optional between pitch accents.\(^{18}\)

Figure 22: Three different contexts need to be stated for deletion of L in \(H^*+L\).

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\(^{18}\) The context for L-deletion could be simplified by analysing IP-internal and IP-final pitch accents as different categories (i.e. \(H^*\) and \(H^*+L\) or \(H^*+L\) and \(H^*\), respectively), but the analysis would still be less parsimonious than the present account.
6.3.1.5. H+L*

This still leaves the question of why the IP-final rising-falling movement should not be assumed to have an L* as its final target, preceded by a leading H-tone. This fifth alternative captures the categorical distinction between IP-final rising and rising-falling movements as a difference in pitch accent (H+L* versus H*). There are three reasons for assuming that the starred tone involved in IP-final rise-falls is high. The analysis as H+L* predicts the occurrence of flat hats, unless L-insertion is stipulated to be obligatory in this particular context. In the analysis with H*, the fact that L-insertion and downstep are complementary solves this problem. Moreover, the analogy between IP-internal and IP-final rising-falling movements is lost, as the former obviously cannot be accounted for by means of an H+L* pitch accent. Finally, some tentative evidence for the assumption that it is the boundary tone which distinguishes between IP-final rising and rising-falling movements can be derived from their alignment with accented syllables that are followed by a schwa, as shown in the examples given in Figure 23.19

![Diagrams of pitch contours]

**Figure 23**: Evidence for the distinction between H% and L% in IPs in which the final schwa is pronounced. Pitch falls from the peak in the accented syllable onto the schwa in *virage* ‘bend’ and *boucle* ‘loop’ (top panels), but it continues to rise in *orfèvre* ‘silversmith’, *boucle*, and *feuille* ‘paper’ (bottom panels). The accented syllable is marked by a shaded box.

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19 The word-final schwa is normally not realised.
Auditorily, the realisations in the top and bottom panels of the figure are discretely different. The movements in the top panels sound like any other rising-falling movement realised on an Intonation Phrase final accented syllable, even though the high target is realised much later in the accented vowel, and the low target is consistently realised after the accented syllable. This fact argues for the view that the high target represents the starred tone.

6.3.2. Falling movements and movements with a pre-accentual peak

All movements in which pitch is falling towards the accented syllable have an H* tone. The absence of a preceding low tone triggers downstep in the phonetic implementation. At the end of the Intonation Phrase, L% leads to an implementation of H* at the bottom of the fundamental frequency range, and when there is no boundary tone, H* is realised at mid level. The distinction between falling movements over more syllables and movements with a fall from a pre-accentual peak is attributed to the specification of the pitch accent, H* and H+H*, respectively.

The obvious alternative for this analysis is (H+)L*. An important argument in favour of (H+)L* is that it allows us to distinguish between falls and rises, which are reported to contrast in most languages of the world, in terms of different starred tones. One argument against an underlying L* tone is the absence of any evidence for a low target in IP-internal falling movements and IP-final movements in which pitch only falls to the middle of the fundamental frequency range. Yet, this is obviously not the case in final falls to low, and therefore, the former could be argued to have an H*-tone and the latter an L*-tone.

However, if falls to mid and falls to low are distinguished in the pitch accent inventory in this way, the similarity in meaning of the intonational categories is no longer reflected by a similarity in their phonological specifications (Gussenhoven 1984:267-287; Gussenhoven and Rietveld 1991). Although IP-final falls to mid sound less definite than those that fall to the bottom of the range, both function as markers of finality, and are primarily used to signal assertions. This generalisation also applies to movements with a pre-accentual pitch peak (cf. Chapter 5 sections 5.2.4 and 5.2.5). Moreover, the only consistent realisational difference between IP-final falls to low and IP-internal and IP-final falls to mid appears to be the difference in the pitch level of the accented syllable.

The analysis of sequences of descending plateaux in English, Dutch and German provides another argument for treating French falling movements as downstepped H*. In these languages, the contour is described as a series of downstepped H*(L) (Ladd 1983; Van den Berg et al. 1992; Féry 1993; Grabe 1998a), as is exemplified for Dutch in Figure 24 (from Gussenhoven 1991b). Assuming that the last tonal target is L* instead of downstepped H* in French implies that the French contour is structurally different from very similar contours in German, English and Dutch.
Figure 24: The analysis of a series of descending plateaux associated with accented syllables in Dutch.

A further reason for rejecting L* derives from the realisation of falling movements in which the accented syllable is followed by a schwa or a stretch of unaccented syllables. As can be seen in Figure 25, pitch falls throughout the accented syllable and only reaches the bottom of the fundamental frequency range in the final schwa (from the spontaneous speech corpus).

Figure 25: Pitch continues to fall in the schwa after the accented syllable of the falling movements to low in *nouveau phare* ‘new lighthouse’ and *moyen âge* ‘middle ages’.

In addition, some utterances were found in the spontaneous speech corpus in which a postposed unaccented interjection followed the utterance-final pitch accent, illustrated in Figure 26. In these examples, the lowest point is also reached in the final unaccented syllable of the utterance. This suggests that a downstepped H-tone followed by a low boundary is better suited to account for the data.
Figure 26: Pitch continues to fall on the postposed interjection in ...à peu près en face, quoi ‘... almost in front, [what]’, Tu contournes la maison, oui ‘You skirt round the house, [yes], and ...juste après l’arrondi, quoi ‘... just after the roundness, [what]’. The accented syllables are shaded; the interjections are marked by boxes.

Similarly, the realisation of post-accentual syllables after a movement with fall to mid support an analysis as downstepped H*. As Ladd (1996:141) argues, the movement with the penultimate peak should be analysed as L+H+!H*, because the post-accentual syllables are realised at the same level as the final tone of the matrix sentence, which is mid. Ladd’s analysis is exemplified in Figure 27 (Ladd 1996:142; cf. Dell 1984).

Figure 27: The pitch level of the right-dislocated constituent continues at the level of the pitch accent in Parce qu’il n’avait plus d’argent, Mercier ‘Because he didn’t have any money, Mercier’.
With Ladd, we believe that the mid level realisation is best accounted for by means of downstep, although in our analysis, there is no leading L-tone (cf. footnote 18 above), and we do not account for the pitch level of the syllables following H+H* by copying the final tone of the matrix sentence, as Ladd does (i.e. L+H+!H* !H), but leave the boundary unspecified for tone (i.e. %L H+H* 0% with phonetic spreading of %L and downstep of H* in the example of Figure 27).

Finally, if a pitch accent (H+)L* is incorporated as a separate category in the pitch accent inventory, the distinction between (H+)L* and H* should lead to a number of phonological contrasts that are unattested in French. That is, one would expect to find contrasts such those found in British English in Figure 28 (the phonological transcription follows Gussenhoven 1984).

![Figure 28: The contrast between L*H and H*L in British English.](image)

Moreover, the analysis predicts a distinction between L*H% and H*H%, which wrongly suggests that the categorical difference in final rises is related to a consistent difference in the timing of the low target instead of the height of the peak (this issue will also be addressed in Chapter 7).

6.4. Discussion

The Autosegmental-Metrical analysis proposed in this chapter specifies the following tonal primitives at the level of the phonological representation: (1) the pitch accents H* and H+H*, which associate with metrically strong syllables, (2) the IP boundary specifications %L, %H, L%, H% and 0%, and (3) an L-tone, which is optionally inserted between two pitch accents. The tones are associated with the 'text', and interpreted in terms of fundamental frequency and time alignment in the phonetics. H* tones that immediately follow a high tone (including H+) are phonetically implemented as downstepped H* unless the IP is closed by H%.

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20 Also, as we have argued above, the evidence for the high target as the starred tone in the final rise is more convincing.
Spreading accounts for phonetic variants in which pitch continues at the level of the preceding tonal specification. This means that it is not necessary to distinguish an underlying from a surface structure in the phonological level of representation in order to account successfully for intonation contours in French.

As in Jun and Fougeron’s and Di Cristo and Hirst’s accounts, the incorporation of tonal specifications for accented syllables and boundaries as separate elements in the phonological description naturally accounts for the fact that a greater number of intonational contrasts occurs in IP-final position than elsewhere (Hirst and Di Cristo 1984; Di Cristo and Hirst 1993, 1996, 1997; Di Cristo et al. to appear; Jun and Fougeron 1995, to appear). Also, all movements are derived from the same underlying categories; there is no difference between them at the level of the tonal inventory, and intonational contrasts only arise when the tones of the inventory are associated with the segmental structure. The accounts differ in the tonal elements included in the inventory and the way in which the derivation of the surface forms is formalised. For instance, both Di Cristo and Hirst and Jun and Fougeron phonologically analyse the basic pattern of rising movements as LH sequences (LH and LHiLH*, respectively), while in the present description, the low tone is not necessarily there. Moreover, Jun and Fougeron’s description is different from the others in adopting ip-final boundary tones (L- or H-), and Di Cristo and Hirst’s is different in specifying a number of phonological rules that adjust the tonal specification. In the remainder of this section, the major discrepancies between Jun and Fougeron’s and our account will be discussed first, followed by a comparison with Di Cristo and Hirst’s account.

6.4.1. Jun and Fougeron’s account

Jun and Fougeron assume that French intonation is organised into the prosodic levels of the Accentual Phrase (LHiLH*), the Intermediate Phrase (L- or H-) and the Intonation Phrase (L% or H%) (see Chapter 2 section 2.2.1). They follow Pierrehumbert (1980) in assuming that the phonetic realisation of the intonation contour is directly derived from the phonological representation. Phonetically unrealised tones are accounted for by means of phonetic undershoot. As mentioned in Chapter 2, the four major differences between Jun and Fougeron’s account and the one proposed here are the following.

- Jun and Fougeron distinguish between word-initial and word-final pitch movements at the phonological level (Hi versus H*); both are pitch accents in the present proposal.

- The tonal specification of the AP, LHiLH*, would appear to imply that all four tones belong to the same tonal morpheme. No such implication exists in our treatment, where the tone string is assembled from boundary tones, pitch accents and an L-tone, and the length of the tone string depends on the number of accents.
AN AM ANALYSIS OF THE INTONATION CONTOURS

In Jun and Fougeron’s model, the tones of the phonological specification are often unrealised and H-tones can be realised as L-tones. In the account proposed here, all phonological tones are phonetically implemented.

Jun and Fougeron adopt an Intermediate Phrase with its tonal specification L- or H-, which is absent in the present account. These points will be discussed in the following subsections.

6.4.1.1. Hi versus H*

The present analysis is different from Jun and Fougeron’s account because pitch accents, or tones in general, do not project prosodic constituents. The Phonological Phrase determines where pitch accents are located, but the tonal specification of the accents is independent of the prosodic structure (cf. Chapters 3 and 4). That is, the tonal morphemes are listed in the phonological inventory, and speakers select these for association with these locations. This means that word-initial and word-final pitch movements are not considered to be phonologically distinct tonal categories, as in Jun and Fougeron’s account, who only use the star to mark the tone that associates with the AP-final stressed syllable. Although Hi normally also associates with a stressed syllable (secondary stress in a word), it is not treated as a pitch accent. The unspoken assumption appears to be that the full specification of the French pitch accent is LHiLH*, in which LHiL function as leading tones (cf. following subsection).21

This view is based on two arguments. First, Jun and Fougeron claim that Hi is not always realised on a full vowel, i.e. vowels as in petit which can be pronounced as /pɛtɪ/ or /ptɪ/. This means that they assume that pe with a pitch peak (Hi) in, for instance, le petit pain ‘the small bread’ has a reduced vowel. However, this vowel is often realised as /œ/, which suggests that the accented vowel is not in fact reduced. The second argument is that the syllable with the Hi tone is not necessarily longer than unaccented syllables, while the syllable with the H* tone is. However, in French, accented word-final syllables always coincide with some prosodic constituent boundary (the word, the AP/PP, the IP or the utterance), and these boundaries are also marked by final lengthening when the syllable is not accented. Therefore, final lengthening may be independent of pitch accent or tone. In the present analysis, the absence of other acoustic correlates to signal the prominence of word-initial pitch movements falls out from their position in the prosodic structure, as in Di Cristo and Hirst’s description.22

An argument for treating the first high tone as a pitch accent is its behaviour in emphatic speech, which in our view is very similar to that of a focal accent realised on the same syllable. Jun and Fougeron claim that Hi can be promoted to a pitch

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21 As Hi can also be aligned with the second syllable of a polysyllabic word, it does not seem to be a boundary tone (marking the initial boundary of the prosodic word).
22 Traditionally, the distinction between word-initial and word-final pitch movements is also based on a difference in function (emphatic/rhythmic versus demarcative), but the function of the pitch movements is not at issue here (cf. introduction to Section 5.3 in Chapter 5).
accent in utterances with early focus. Thus, initial syllables can have high-toned pitch accents after all, and this even includes syllables that do not have a full vowel, as is shown in Figure 29.

![Graph of pitch accent in French]

**Figure 29:** Example of a focal accent on a word-initial syllable in Jun and Fougeron's transcription.

This means that the formal distinction between H* and Hi can only be maintained if the focal accent is considered to be phonologically distinct from non-focal Hi and H*. In our view, focal and non-focal accents have the same tonal structure with different degrees of prominence. The acoustic differences between the two are gradual rather than categorical in nature. That is, Hi and H* can be made more prominent in emphatic speech by increasing the height of the pitch peak, the duration and intensity of the segments, their voice quality, etc., but this does not involve a different choice from the tonal inventory. For instance, *C'est fantastique* 'It's fantastic' with a pitch peak on *fan* will sound increasingly more enthusiastic as the duration, height and amplitude of *fan* are increased. We believe that the same applies when *fantastique* has early focus, as in *J'ai dit FAntastique, pas Elastique*. Although the stretch following the focal accents will be more or less flat and deaccented, the acoustic realisation of the pitch accents themselves is similar to an emphatic pronunciation, and the degree of prominence of the focal accent can also be varied in the same way. Thus, there is little formal evidence for a phonological distinction between focal and non-focal accents in terms of their tonal structures, and the fact that pitch accents can also be realised on initial syllables appears to argue against a distinction between Hi and H*.

In fact, it might even be questioned whether the notion of pitch accent should be used to describe pitch movements in French at all. In the Autosegmental-Metrical accounts of intonation in West-Germanic languages, the diacritic ‘*' in the pitch accent specification is used to mark the tone that associates with a metrically strong position (e.g. Leben 1976; Pierrehumbert 1980; Gussenhoven 1984). Thus, tones that align with stressed syllables can be distinguished from tones which align with prosodic boundaries. In French, changes in pitch only appear to occur on stressed syllables (cf. Figure 1 above), but the location of the stressed syllables is highly predictable; stress is not dynamic in French (cf. Chapter 1). Hence, the diacritic is not needed to regulate the alignment of the tones. Also, no phonological distinctions hinge on the location of the star in the tonal string. That is, there are no phonological contrast such as that between L*+H and L+H* in English, as is shown in Figure 30 (adapted from Pierrehumbert 1980:221; cf. Section 6.3). This means that the location
of the star is also irrelevant to the description of the phonological contrasts in French.  

![Figure 30: The location of the starred tone distinguishes between L*+H and L+H* in English.]

Nevertheless, the term pitch accent is adopted here to indicate the class of tones that associate with metrically strong positions, and the star is used to indicate the tone that is aligned with the stressed syllable. Doing so is convenient, because the phonological contrasts can be captured more parsimoniously, as was shown in the preceding sections.

6.4.1.2. LHiLH* as a tonal morpheme

Apart from the question whether Hi in Jun and Fougeron's LHiLH* should be considered a starred tone, the specification implies that the tones belong to the same tonal morpheme, which they do not in Di Cristo and Hirst's analysis and the one proposed here. Jun and Fougeron's argument for this assumption is that the tones of the AP show a greater internal cohesion than tones which belong to different APs (Jun and Fougeron to appear). More specifically, the timing of an H-tone and the following L-tone depends on the number of intervening syllables when both belong to the same AP (i.e. the Hi and the following L in LHiLH*), but it is constant across AP boundaries (i.e. H* and the following L in LHiLH*LHiLH*). Thus, the tones of different APs behave independently of each other, but within an AP, they do not.

However, this apparently greater tonal cohesion can also be explained on the basis of the prosodic structure alone. The Phonological Phrase of the present description spans the same domain as the AP in most contexts, as both are delimited by a word-final accented syllable. The analysis of Chapter 4 predicts that Phonological Phrases are realised with an early accent if an appropriate syllable is available. Since this syllable is usually preceded by at most one or two unstressed syllables (of function words), its distance to the final accented syllable of the preceding phrase is likely to be smaller and less variable than its distance to the final

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23 This does not mean that bitonal pitch accents are necessarily excluded in French, only that the location of the star cannot be used distinctively in the tonal string. For instance, the analysis presented in this chapter has H+H*, but there is no contrasting H*+H.

24 Thus, *de jolis airs* would be both AP and PP. Only when a PP is realised with more than one word-final pitch accent the domains do not coincide, as in *de jolis enfants*, which is [LH*]AP[LH*]AP in Jun and Fougeron's account, and [LH*]APPP here.
accented syllable of the same phrase. Therefore, the difference in alignment observed by Jun and Fougeron does not have to be related to the phonological structure of the intonation contour. Also, in our data, the initial low target of LH* only occurs in initial position when (1) Hi is realised on the first or second syllable of the phrase or (2) it is preceded by an IP boundary. In most other cases, pitch falls towards the accented syllable. In the example in Figure 31 (from the read speech corpus), speakers CG and CO align the initial L of the second AP with the second instead of the first syllable. Auditorily, the same appears to be the case in the other speakers' realisations, but there, it is only just visible in the pitch trace.

Figure 31: AP-initial L is not aligned with the first syllable of the phrase in *Quand il arrive à la maison de Cendrillon* 'When he arrives at Cendrillon's house' (speakers CG and CO; the APs are marked by boxes).

Thus, unless the number of syllables intervening between the high tones of two APs was systematically varied within one and the same Intonation Phrase in Jun and Fougeron's data, the timing difference they measured does not provide conclusive evidence for their claim (the materials in which the measurements were taken are not specified and no significance levels are given). The figure also shows that speaker CO produces two consecutive word-initial pitch peaks, which cannot be accounted
for in Jun and Fougeron's analysis, because the AP has maximally two high targets (cf. Hirst and Di Cristo 1996). Moreover, the majority of the APs in the figure only have two tonal targets, L and H*, which means that the underlying specification LHiLH* is often superfluous.

6.4.1.3. Direct derivation from the tonal primitives LHiLH* and L% or H%
As there is only one phonological specification for the AP in Jun and Fougeron's account (LHiLH*), and there is no phonological surface level at which the underlying specification is modified, all surface realisations are considered to be allophones of one and the same underlying category as long as they do not involve a boundary specification. The phonetic variants observed in the AP, as listed by Jun and Fougeron, are LHiLH*, HiLH*, LLH*, LHiH*, LH*, and LHi(L)L*. They are accounted for by phonetic undershoot of the underlying tones, or, in the case of LHi(L)L*, by a phonetic realisation rule that optionally changes H* into L* when it occurs between two Hi tones. A striking consequence of this account is that a realisation of c'est fantastique with a pitch peak on fan- and another on -tique is considered to be phonologically identical to a realisation in which only the final syllable has a pitch peak. Also, a surface form with L* is identical to a form with H* at the phonological level, because the difference is described in the phonetics. The account thus blurs the distinction between the phonetics and the phonology, and it might be more appropriate to distinguish three levels of analysis in their account.

Another consequence of adopting LHiLH* as the phonological specification of the AP is that some surface forms cannot be described, and a number of unattested surface forms are generated. As mentioned, two subsequent word-initial pitch movements are excluded (e.g. speaker CO's la maison de Cendrillon in Figure 31). Also, IP-internal sequences of descending plateaux, whether they are believed to be phonologically distinct or not, cannot be described. At the same time, the absence of any phonological constraints on the derivation process results in unattested surface forms when an Intonation Phrase contains more than one AP. The realisations in Figure 32, for instance, cannot be excluded. First, the utterance contains two sequences of immediately adjacent high tones, which, as the investigation of Chapter 3 has shown, do not occur unless a Phonological Phrase boundary intervenes between them. Second, although the rapidly rising-falling movement such as the one on -vait is a possible realisation of the focal accent, such realisations do not occur in non-IP-final position in neutral speech. That is, the low tone following H* is normally aligned later, resulting in a shallower fall.

26 Jun and Fougeron's examination of 466 APs in subject NP position revealed that in only 36% of cases, all four tones of the AP actually surfaced (Jun and Fougeron 1995:723).
Finally, the tonal specification of the AP is often superfluous. In only a relatively small number of instances all tones of the AP actually surface (in the data of Jun and Fougeron (1995), LHILH* only surfaces as such in 36% of cases, and Hi, for instance, is omitted in 26% of cases). In the present proposal, tones are represented in the phonology if and only if they have targets at the phonetic level.

The derivation of the phonetic realisation from the tonal specification also leads to a number of complications in IP-final movements. According to Jun and Fougeron, the H* tone of the IP-final accented syllable is pre-empted, or overridden, by the higher level boundary tone (L% or H%), because both are associated with a single syllable. In this way, IP-final rising and falling movements can be distinguished, but it is unclear how the rise-fall, in which pitch falls from a peak in the accented syllable, can be generated. Also, falling movements appear to be excluded when the final syllable of the utterance is a schwa. Since here, H* and the boundary tone associate with different syllables, there is no obvious reason why the H*-tone should be pre-empted.

6.4.1.4. The intermediate phrase (L- or H-)

The adoption of an intermediate phrase, which also projects boundary tones, further complicates the analysis. The ip is argued for on the basis of the realisation of utterances with early focus as in Marion ne mangera pas des ananas au petit déjeuner, mais Marion mangera des BANANES au petit déjeuner ‘Marion will not eat ananas for breakfast, but Marion will eat BANANAS for breakfast’ (example from Jun and Fougeron, to appear). In a production experiment, Jun and Fougeron found that the accent on bananes can be realised on the first or the last syllable of the word (the location of Hi or H*), and that the post-focal stretch either formed a new Intonation Phrase or was deaccented. In the latter case, the post-focal stretch was realised as a low plateau in declaratives and a high or mid-high plateau followed by a final rise in interrogatives. The low plateaux are accounted for as L-L%, and the mid-high and high plateaux as H-H%, where T- spreads to the end of the focussed word, and H- causes H% to be upstepped. The ip is also used to account for the intonation contours of tag questions, dislocated theme/rheme structures, wh-questions and intonational clichés.
In the remainder of this subsection, it will be argued that the IP boundary tone makes the derivation of the surface form unnecessarily complex, predicts phonological distinctions that cannot be motivated, is often superfluous, and finally, fails to account for some of the contrasts that have been attested in the literature.

Since the intermediate phrase is defined at the level below the Intonation Phrase in the prosodic structure, T% must always be preceded by T-. It is unclear how this affects the pre-empting of H* by T%. It would be logical to assume that T% overrides both H* and T- when all three tones are realised on the same syllable. If so, H*H-H% and H*L-H% would surface as H%, and H*H-L% and H*L-L% as L%. However, Jun and Fougeron’s account of movements with a pre-accentual peak hinges on the assumption that T% does not pre-empt T-. As is illustrated in Figure 33, H* moves to the penultimate syllable, and T- and T% co-occur on the final syllable in such cases (example from Jun and Fougeron to appear). In vocatives, for instance, the final syllable can be pronounced at mid level, and this mid tone is created by a combination of downstep of H- (after H*) and upstep of L% (after H-).27

![Calling contour:](H* H-L%)

\[ Joanna \]

Calling contour: 'Implication':

\[ H* H-L% \]

... des circonstances objectives

'... objective circumstances'

Figure 33: T% does not pre-empt H* and T- in Jun and Fougeron’s account of movements with a penultimate unaccented peak.

This analysis raises a number of questions. First, why should the overriding of T%, which is necessary to derive the IP-final fall, make exception for IP boundary specifications? Second, why is H* not pre-empted by H% or L% before it is moved? Since the surface realisation is directly derived from the tonal representation, it is unclear how H* can be pre-empted in certain contexts, when it is moved in others. Third, if H* can be moved, what is its alignment conditioned by? Apparently, H* only ever moves to one particular syllable (i.e. the penultimate), and not all H* can do so. That is, it only seems to take place in IP-final position (as in Figure 33). Fourth, the association of H* with a word-initial syllable in Figure 33 seems to conflict with Jun and Fougeron’s claim that word-initial and word-final pitch movements are phonologically distinct and should be transcribed as H1 and H*, respectively. Finally, why is there no phonetic evidence for H- and L% in this

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27 Also, if T% pre-empts both H* and T-, distinctions related to the pitch level of the final syllable of the IP-final rise and fall cannot be made (H*0% versus H*H% and downstepped H*0% versus downstepped H*L% in the present analysis).
particular context, when all other combinations of T- and T% are argued for on the basis of their phonetic realisation?

The second drawback of the analysis with T- and T% is that it predicts a number of unattested contours. Thus, H*H-L% does not represent a distinct contour in an utterance with early focus. H*H-H%, H*L-H% and H*L-L% all describe possible surface forms in such contexts (although in our view not all of these differences are phonological), as shown in Figure 34. Since H- is downstepped after H* to account for the intonational cliché with a fall to mid from a penultimate peak, one would expect H*H-L% to surface as the contour in (d), and since, according to Jun and Fougeron, downstep is not obligatory in H*H-H% in (a), the dotted line indicates a variant which does not reflect a pragmatic difference. Thus, the contour indicated by the dotted line in (d), where H- is not downstepped, might be an alternative realisation. Yet, neither contour in (d) appears to occur in French.

Figure 34: Jun and Fougeron’s predictions for an early focus utterance with H*T-T%.

In our account, H* can only be combined with H% (the realisations in a), L% (realisation in c) and 0% (cannot be described by Jun and Fougeron, unless H*H-L% is assumed to be realised as an accentual peak followed by a mid level plateau). The realisation in (c) would be a variant of one in which the peak is followed by a gradual fall to the Intonation Phrase boundary (both H*L%).

A similar problematic prediction arises in Jun and Fougeron’s account of the intonation contours in dislocated constructions, such as Ça lui plairait, une bonne bouteille de champagne ‘That would please him, a good bottle of champagne’ (example originally from Di Cristo and Hirst 1996). When pronounced as a declarative sentence, the constituent is characterised by low level pitch, and in an

28 Jun and Fougeron’s motivation of T- covers every combination of H*T-T%, and therefore, we have to conclude that there are no distributional restrictions on the tones.
interrogative reading, it is high (Di Cristo 1998). As shown in Figure 35, such utterances contain two ips in Jun and Fougeron’s analysis, and the level tone is represented by the ip boundary tone. Presumably, the Intonation Phrase boundary tone is the same as the preceding specification in the examples.

This account predicts that the T- of the first ip can also be followed by all other combinations of T- and T% (eight in all), which each represent a phonologically distinct contour. Although Jun and Fougeron offer no account of how the tones interact and where they would align, the assumption of a deaccented ip would appear to predict at least one representation that does not have a conceivable surface realisation (H*L-H-L%), and at least one realisation that is identical to another in its realisation (H*L-H-H% and H*L-L-H%).

![Diagram](image)

**Figure 35:** Jun and Fougeron’s account of right-dislocated structures with H*T-T%.

The third argument against T- is that it is often superfluous. Although it can serve to transcribe apparent tonal targets in some cases, it does not have to be reflected in the phonetic realisation, and is therefore not always a decisive element in the analysis of the movement concerned. For instance, the mid ending of the movement with the penultimate peak may be accounted for in a way that avoids moving a starred tone to an unstressed syllable. In our account, a downstepped starred tone is associated with the final syllable, and it is realised at mid level, because the following Intonation Phrase boundary is left unspecified for tone (0%). Thus, there is no need to posit a combination of two boundary tones that have no apparent phonetic target (H- and L% in Jun and Fougeron’s account). Unless phonetic cues are found to confirm the existence of the ip as a prosodic constituent, there is no reason to adopt it for French.
A situation in which the analyses diverge arises when the post-accentual stretch ends in a low tone, which constitutes our fourth objection against T-. Realisations in which the pitch is interpolated from the H* tone to the L% boundary are phonologically identical to their low level counterparts in the present account (cf. Figure 34 (c) above). Presumably, Jun and Fougeron would transcribe the difference as H- as opposed to L-. In our view, the height of the pitch between H* and the end the IP does not function categorically, but is gradiente variable.

6.4.2. Di Cristo and Hirst’s account

Di Cristo and Hirst propose a three-layered prosodic structure to account for French intonation: (a) the Tonal Unit delimited by an L and an H-tone on either side, (b) the Rhythmic Unit which captures differences in metrical strength, and (c) Intonation Units which are delimited by an L-tone on their left, and an L- or H-tone on their right (Chapter 2 section 2.2.2). They adopt two phonological levels of representation, and further distinguish a phonetic from a physical level of representation. The most important differences between the account of Di Cristo and colleagues and ours are the following.

- The Tonal Unit is the minimal unit of tonal description in Di Cristo’s and Hirst’s account; its equivalent in the present analysis is probably the accented syllable, with which the (H+)H* pitch accent associates. Unlike our tonal and prosodic units, the TU violates the Strict Layering hypothesis (Selkirk 1990:180).
- Di Cristo and Hirst adopt the Segment d’UI (not tonally defined) to account for intonation contours involving dislocated constituents; there is no equivalent in the present analysis.
- Instead of Di Cristo and Hirst’s four levels of representation, the present account only has two.

6.4.2.1. The TU and the Strict Layering Hypothesis

Two aspects of Di Cristo and Hirst’s prosodic structure are important to the present discussion. First, the Tonal Unit violates a well-formedness constraint referred to as the Strict Layering Hypothesis (SLH). According to this principle, an utterance is exhaustively parsed into strictly layered constituents on every prosodic level, that is, a constituent can only dominate constituents of lower types. As can be seen in Figure 11 of Chapter 2, the TUs for un jo- and -li bateau violate the SLH, because they do not coincide with word-boundaries. Although the TU can be defended on the

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29 Jun and Fougeron’s and Di Cristo and Hirst’s examples show that pitch is not completely level throughout the constituent in the variant referred to as low level (Di Cristo and Hirst 1996; Di Cristo 1998; Jun and Fougeron to appear).

30 But note Ladd (1992) who doubts the applicability of the Strict Layer Hypothesis to intonation.
grounds that other generally accepted prosodic constituents also violate the SLH (see Ladd 1992 and Hirst and Di Cristo 1996), no such violations are necessary in the analysis presented here.

6.4.2.2. The Segment d'UI
Di Cristo and Hirst claim that in dislocated constituents, the low or high level stretches form a Segment d'UI ‘segment of the Intonation Unit’, which is an integral part of the higher-level IU, for instance IU[Ça lui plairait] une bonne bouteille de champagne]IU. Its realisation is accounted for by means of tone copy of the IU boundary tone (Di Cristo and Hirst 1996). Note that Tone Copy as proposed by Gussenhoven (1988) always copies the tonal specification from the preceding specification. Thus, a three-way distinction between an utterance with a single IU, one with an embedded Segment d'UI, and one with two IUs exists, which each have a phonologically different tonal structure, as is illustrated in Figure 36 (adapted from Di Cristo and Hirst 1996; we are not sure about the exact location of the tones relative to the segmental string).

![Diagram of IU/IP structures](image)

Figure 36: Di Cristo and Hirst’s predictions compared with those of the present analysis for falling movements (left) and rising movements (right) realised in a single IU/IP (top) and an IU/IP with a right-dislocated constituent (bottom).

This means that Di Cristo and Hirst, like Jun and Fougeron, assume that there is an intermediate constituent boundary after plait in the bottom realisations, which is motivated on the basis of the melodic realisation of the utterance alone. Unless the difference between the contours indicated by the solid and dotted lines in the bottom left example is shown to be categorical, or cues other than pitch are found to confirm
the presence of this prosodic boundary, there is no reason to adopt such an intermediate prosodic constituent.

6.4.2.3. Levels of representation
Di Cristo and Hirst's account is more parsimonious than Jun and Fougeron's, thanks to the fact that it incorporates two phonological levels of analysis. This allows them to derive a wide range of phonetically explicit surface forms from only two underlying tonal specifications, \([LH]\) and \([LL]\), while the number of forms that can be generated is constrained. Nevertheless, the way in which the derivation process is formalised has some drawbacks. Firstly, the account confounds the phonological surface and phonetic levels of representation, which leads to some confusion about the number of phonological contrasts that are distinguished. The INTSINT symbols, which represent the instructions for the phonetic module, are derived from the underlying representation by means of a set of rules, as is shown in Figure 37 (adapted from Di Cristo et al. to appear).

![Figure 37: Di Cristo and Hirst's derivation of intonation contours.](image)

One of these rules, tonal conversion, automatically maps tones onto registers. For instance, initial \(L\) always becomes \(M\) (middle of the range), and final \(L\) always becomes \(B\) (bottom of the range), as is shown in the figure. This process must be a matter of phonetic implementation rather than phonological transformation, as it never results in phonological distinctions. Also, \(LH\) and \(DH\) (i.e. Downstep High; detachment of \(L\) in \([LH]\) triggers downstep; see Figure 37) are assumed to be
allophones, which suggests that downstep is not a phonological rule (i.e. phonetic implementation as in the present analysis). This interpretation is further supported by the fact that INTSINT is compared with the International Phonetic Alphabet (Di Cristo and Hirst 1996). However, the transformations are explicitly claimed to generate the phonological surface representation elsewhere (Hirst and Di Cristo 1984; Di Cristo et al. to appear). In fact, most of the discretely different contours only arise after the application of (some of) the rules. For instance, the contrast between DH and UH (Upstep High) and that between LH and D depend on the transformations, and therefore, the rules have to be phonological in nature. As a consequence, it is unclear to what extent the derived patterns are assumed to be discretely different. We have to conclude that the endeavour for phonetic explicitness, which is probably motivated by suitability for text-to-speech synthesis, undermines the phonological explicitness of the description. In our view, a clearer division of labour between the levels of representation, in which part of the derivation process (e.g. tonal conversion) is promoted to the phonetic component of the grammar, does not encroach on this aim, while it allows us to make clearer predictions about discreteness.\footnote{Phonetic implementation needs to be further refined in our model for it to reach the level of phonetic explicitness of Di Cristo and Hirst’s account.}

Secondly, the analysis is unnecessarily complex. Underlying L and H tones need to be eliminated by rule when they are redundant (simplification), and some of them need to be transformed into another tone by a set of rules. In addition, the rules have to be ordered. For instance, the phonological surface form of underlying [L][LH]H]L, which signals emphasis for contrast, is LSTB (LowSameTopBottom). Linearization, giving LLHHL, has to apply first, because it creates the context for the other rules to apply in. Now, the second L and HH have to be transformed into S and T, respectively, before simplification eliminates the sequences of identical tones (which would result in LHL instead of LSTB). In the present analysis, only tones which are phonetically realised are specified in the phonology, and the strict division between the phonological and the phonetic levels of analysis obviates the need for rule ordering.

Finally, the analysis appears to be too restrictive, because it cannot generate some of the movements that were identified in Chapter 5. For instance, IP-initial onsets are predicted to always rise gradually towards the first H-tone. The IU and the first TU project two Ls at the beginning of the IU, which are merged into M (Mid) through simplification and tonal conversion. Therefore, level realisations cannot be generated (unless some implementation rule is added in the phonetic component), and high initial boundaries cannot be described either. In addition, if our interpretation is correct, the analysis cannot make distinctions on the basis of the pitch level of IP-final syllable, because tonal conversion always changes the specification of the final syllable into either B (bottom of the range) or T (top of the range).
6.4.3. Conclusion

The present analysis has the advantage that it is parsimonious, while making the correct predictions. All phonologically contrasting contours are accounted for by means of a small set of tonal primitives, and the number of surface forms that can be generated are constrained in a transparent way. Only tones that have phonetic targets are represented in the phonology, which minimises redundancy in the analysis. Moreover, the way in which the association between the tonal and segmental strings is formalised avoids the necessity of violating the Strict Layering Hypothesis, as is the case for Di Cristo and Hirst’s Tonal Unit and Segment d’UI, nor does it require the introduction of an intermediate constituent for which corroborating evidence is lacking, as is the case for Jun and Fougeron’s intermediate phrase. To conclude, the strict division of labour between the phonetic and the phonological levels of representation makes very explicit predictions about the discreteness of variation in pitch, which can be experimentally verified. The following chapter explores experimental techniques that can be applied to test controversial predictions about phonological distinctions, and to investigate the pragmatic contribution of discrete and gradient variation.
Chapter 7  An experimental investigation of final rises

7.1. Introduction

In the phonological analysis presented in Chapter 6, Intonation Phrase final high rising, rising and rising-falling movements are distinguished from each other at the phonological level: H*H%, H*0% and H*L%, respectively.1 The aim of the investigation reported in this chapter is to provide experimental evidence for the proposed phonological distinction between H*H% and H*0%. Although recent descriptions of French intonation agree that the basic pattern of rising pitch movements can be phonologically analysed as strings of LH (Mertens 1987, 1992; Hirst and Di Cristo 1984; Post 1993; Jun and Fougeron 1995, to appear; Di Cristo and Hirst 1996), there is no agreement about the number of phonologically contrasting categories that should be identified for final rises. More specifically, the variation in the fundamental frequency traces of final rises has been claimed to reflect more distinct categories than the two categories of the present analysis.

Previous intonational research suggests four methods which may be suited to address this question (cf. Gussenhoven to appear). The first method, the imitation task, was applied by Pierrehumbert and Steele (1989) to investigate the contrast between L*+H and H*+L in American English. Subjects were asked to imitate stimuli from a continuum in which the timing of the peak was varied systematically. The results showed that the imitations were not evenly distributed in the continuum, i.e. the subjects failed to reproduce the gradient changes in peak timing. The contrast was therefore concluded to be discrete, reflecting two phonological categories. The phonological identity of French final rises may involve more than one type of variation, which means that a number of different continua would have to be included in the experiment. As this makes the imitation task rather cumbersome and time-consuming, the method was rejected for the present purposes.

The second method, the pitch range task, was used by Gussenhoven and Rietveld (1997) to investigate the contrast between L* and H* in Dutch. In this task, subjects judged the degree of surprise expressed in resynthesised utterances with varying values for the beginning and the end of low and high rises. The opposite effect of pitch range variation found for the low and the high rises could only be explained in an analysis with two underlying categories. Since in the present investigation, the contrast between final rises is hypothesised to derive from the boundary specification (H% versus 0%) instead of a difference between L* and H*, it is unclear whether the pitch range task is suitable for the investigation of the

1 An abbreviated version of this chapter has been published in the proceedings of the XIVth International Congress of the PhoneticsSciences held in San Francisco, August 1999.
distinction in question.

Semantic tasks provide a third possibility for investigating intonational contrasts. The subject’s interpretation of an intonation contour is reflected, for instance, as a rating on a semantic scale (Uldall 1964), as a yes/no decision about the appropriateness of a given meaning (Bartels and Kingston 1994), or as a judgement of acceptability in a particular context (e.g. Caspers 1998). The judgements thus reveal which realisational differences are meaningful. However, as gradient variation can also be meaningful, this method as such does not guarantee that a distinction can be made between realisations that contrast at the phonological level (discrete) and continuously varying phonetic realisations (gradient). As a consequence, it cannot be used to test the two-way phonological distinction between H*0% and H*H% in French. Nevertheless, the semantic task can be used to explore the diverse effects of variation on the interpretation of the final rise, and hence, it may provide an explanation of why there is no consensus about the number and nature of the contrasts in final rising movements. Therefore, a semantic task consisting of contrastive judgements of attitudinal meanings was included in the investigation.

The fourth method, Categorical Perception, can in principle be used to find evidence for phonological discreteness. Although it does not have the drawbacks of the other methods, a number of objections of a different nature can be raised against this method. The objections are related to the fact that speech sounds are not necessarily perceived categorically in the way the classical form of the paradigm presupposes (discussed in Section 7.2). Gussenhoven (to appear) suggests that the paradigm may be applied more successfully to intonational contrasts when an experimental top- and baseline are introduced in the design. We decided to try and see whether this approach would give better results.

In this chapter, the relevant controversies in the literature with respect to the analysis of rising pitch movements will be reviewed first. The issue of phonological discreteness in final rises is addressed in Section 7.2, which reports the Categorical Perception experiment. Despite the introduction of the top- and baselines, the paradigm appears to be unsuitable for the investigation of intonational contrasts. The investigation into the effect of phonetic differences on the interpretation of tonal categories is reported in Section 7.3. The results of the semantic task strongly suggest that gradiently different fundamental frequency variation can be used to signal meaning differences. The implications of our findings for the tonal analysis, and, more generally, for the experimental investigation of intonational contrasts, are discussed in Section 7.4.

7.1.1. Variation within rises

The assumption that rising movements contrast with rising-falling movements in Intonation Phrase final position is uncontroversial. Although final rising movements may show a slight drop in fundamental frequency towards the end of the accented syllable, perceptually, such realisations sound like ‘ordinary’ rising movements, and are not easily confused with final rising-falling movements. Fónagy and Bérard
(1973:80) suggest that such slight drops in fundamental frequency may be non-salient because they are accompanied by a drop in amplitude.

As observed above, there is no agreement about the phonological analysis of differences in fundamental frequency in IP-final rising movements. Three factors have been observed to play a role in the interpretation of rising movements, resulting in different claims about the number of contrasts. These are (a) the direction of pitch in the final syllable (i.e. high level or rising throughout), (b) the height of the peak or the range of the movement, and (c) the timing of the dip of the rise, as is illustrated in (1) below.

Most authors attempt to relate the factors to the grammatical function of the intonation contour, in that they contribute to the distinction between questions, exclamations, and continuations, i.e., prefinal Intonation Phrases. It is not always clear, however, to what extent they propose that these differences should be incorporated in a phonological description.

(1) Direction pitch: 
\[\text{Alors, c'est pas vrai 'So it isn't true'}\]

7.1.1.1. Pitch direction

The direction of the pitch in the final rise has been claimed to distinguish between continuation rises, which have slightly rising or high level pitch in the final syllable, on the one hand, and question and exclamation rises, which have rising pitch throughout the final syllable, on the other (Faure 1973). If this difference can be attributed to a difference in boundary specification (i.e. H*H% versus H*0%), the situation in French mirrors a similar distinction described for English, German and Dutch. In these languages, a rise on an accented syllable may be followed by a level stretch or a rising movement to the end of the Intonation Phrase or the utterance, as is shown in (2).

(2) a. 'rise-level' b. 'continuing rise'
\[\text{It's a UNicorn It's a UNicorn}\]

In Pierrehumbert's (1980) description of American English, the contours in (2) are analysed as a pitch accent L* which is followed by a phrasal high tone (H-). In (2a), H- precedes L% and causes the low boundary tone to be upstepped, resulting in a realisation at the level of H-. The high rising boundary in (2b) is represented as L* H- H%. Gussenhoven (1984) describes the same difference for British English by
means of the modification 'half-completion', which is implemented as a difference in boundary specification in Gussenhoven en Rietveld's synthesis system developed for Dutch intonation (i.e. L*H % versus L*H H%, Gussenhoven en Rietveld 1992). Grabe's (1998a) contrastive study of German and British English intonation contours also describes the difference as a difference in boundary specification. In both languages L*H0% (2a) contrasts with L*HH% (2b). For Dutch, the contrast in (2) has also been described by 't Hart, Collier and Cohen (1990), who transcribe the accent-lending rise followed by level pitch in (a) as '10', and the accent-lending rise followed by a second rise in (b) as '12'.

Various claims have been made about the functional difference between these rises. For Dutch, Caspers (1998) has shown that the nature of final rise (level or continuing) plays a significant role in the signalling of turn keeping. She found that a speaker can use the rise-level to indicate that he wants to keep the floor, and that the continuation of the rising movement is a necessary requirement for a question interpretation. This latter finding would appear to tie in with Gussenhoven's (1984) suggestion that speakers use half-completion to signal that the message is somehow expected, that it should not come as a surprise to the hearer, and that the hearer should not attach too much importance to it (1984:223). This implies that the two rises are not interchangeable in Dutch. Similarly, research on German final rises suggests that rise-level intonation serves as a prototypical turn keeping cue (Selting 1996). However, Grabe (1998a) shows that in lists, the two rises may be used both in questions and in continuations in German, where the choice between the two seems to depend on the speaker rather than the grammatical function expressed in the utterance.

This means that Faure's claim about the role of pitch direction in French could be interpreted to reflect a phonological contrast similar to that in Dutch, where pitch direction appears to be related to the difference between questions and continuations. However, it is doubtful whether the direction of the movement alone is a sufficient cue in French. Unlike English, Dutch and German rises, the French rise will normally have to be realised on one syllable. It may therefore be the case that in certain contexts, lack of time does not allow the difference between rise-level and continuing rising movements to become perceptually salient. Instead, the functional differences may be related to differences in peak height. Faure's findings point in this direction.

7.1.1.2. Peak height or pitch range

Faure (1973) claims that continuation rises are different from question and exclamation rises, because they do not end at the highest pitch level (in his data, the starting point of the rise can always be higher, equal or lower in pitch than the preceding syllable). Similarly, Rossi (1981) claims that questions have a greater range than continuations. Also, Di Cristo (1971 cited in Faure 1973) has shown that when a final rise is systematically shortened (i.e. the value of the peak is lowered), the interpretation categorically changes from question to continuation.2

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2 Similarly, Faure (1973) shows that the bigger the part of the rise that is removed (from the right), the
Delattre's and Martin's descriptions formally distinguish between intonation contours on the basis of peak height (Delattre 1966b; Martin 1975b, 1977; cf. Chapter 5 section 5.3.2). Although in their descriptions, questions and continuations may end at the same pitch level, it is distinctive within continuations. Two continuations are defined, where the difference is attributed to the strength of the following prosodic boundary. Delattre analyses them as *Continuation Mineure* versus *Continuation Majeure*, and Martin as C1 versus C3.

Finally, Léon (1992) claims that shallower rises signal continuation, and steeper rises questions or exclamations (also Léon and Bath 1987 cited in Di Cristo 1998), where the height of the peak distinguishes between the latter two (cf. Faure 1973; Fónagy and Bérard 1973). Evidently, reference to 'steepness' confounds the contribution of the factor peak height on the one hand and that of timing on the other. That is, steepness may not only depend on the height of the final high target, but also on the timing of the low target, as is illustrated in (3).

(3)  

<table>
<thead>
<tr>
<th>Height peak</th>
<th>Timing dip</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steep rise:</strong></td>
<td>![diagram]</td>
</tr>
<tr>
<td><strong>Shallow rise:</strong></td>
<td>![diagram]</td>
</tr>
</tbody>
</table>

In sum, the evidence appears to support a phonological distinction on the basis of peak height, but the frequent reference to the steepness of the rise in the literature suggests that timing may also be involved in such a distinction.

7.1.1.3. Timing

The timing of the dip before the final rise has been to found vary from late in the penultimate syllable to late in the final one (cf. Chapter 5 section 5.2.2). This timing difference has also been claimed to give rise to two different phonological categories. According to Mertens (1992), a late rise sounds more affirmative than an early rise when they are used in a continuation context, and he analyses them as an LH as opposed to an HH accent (both are preceded by a low tone).

However, several findings indicate that the timing of the dip may not in fact be contrastive. Thus, the location of the dip in word-final rises has been reported to be sensitive to the number of syllables that precede the rise (Jun and Fougeron to appear), and to the duration of the phonemes the rise is associated with (Grabe et al. 1998b). Moreover, in our read speech data, speakers were found to produce early and late alignments of the dip in identical contexts in which there was no reason to

more likely a 'terminal' interpretation becomes.

3 Jun & Fougeron (to appear) found that the timing of the low tone depends on the number of syllables that precede the AP-final rise. Grabe et al. (1998b) showed that in question rises, the distance between the low and the high target is constant, which implies that the timing of the low tone relative to the final syllable depends on the duration of the phonemes the rise is associated with.
assume that they were attempting to express different grammatical functions or different attitudes (cf. Chapter 5 Figure 14). Vaissière (1974) made a similar observation. In other cases, an effect on the interpretation of the rise seemed more likely, although the grammatical function of the utterance still had to be the same across speakers. Possibly, these were all instances of Mertens’ continuation cases in which the late rise is claimed to convey some sort of attempt on the part of the speaker to involve the listener (Mertens 1986). Similarly, in the Map Task data, the dip in final rises was often realised much later when the speaker wanted to elicit a confirmation from the listener, as shown in Figure 1 (also described in Mertens 1987).

![Graph showing data from the Map Task corpus.](image)

A: *(il est)* plus haut que les granges effondrées.  
B: Oui.  
‘(It’s) higher than the collapsed barns’  
‘Yes’

**Figure 1:** A late rise signalling a request for confirmation. Data from the Map Task corpus.

In sum, these findings suggest that the timing of the dip does not involve a phonologically contrastive distinction. Instead, it may depend on a combination of factors, such as the segmental structure of the accented syllable (e.g. the rise is more likely to start late in syllables with voiceless onsets). Nevertheless, it seems likely that timing can affect the attitudinal meaning of the utterance.

### 7.1.1.4. Summary

It is unclear to what extent differences in fundamental frequency in French final rises are to be accounted for as phonological contrasts. On the best available evidence, we hypothesise a contrast between H*0% and H*H% which is primarily reflected in a difference in peak height, and that differences in timing and direction are gradient. A Categorical Perception experiment was designed to test these hypotheses. A subsequent experiment explored the pragmatic effect of gradient phonetic variation.
7.2. Experiment I: Categorical Perception

A well-established method for investigating the existence of categories is the Categorical Perception paradigm (CP) (Liberman et al. 1957; Studdert-Kennedy et al. 1970). In this paradigm, subjects perform two tasks. In an identification task, they are asked to identify a stimulus taken from an acoustic continuum as a member of one of two categories. The extreme points of the continuum represent the canonical realisations of the categories concerned. Before the actual identification task starts, subjects are trained to recognise the categories with the help of clear exemplars. If the continuum indeed represents two underlyingly different categories, subjects should identify all stimuli towards the extremes of the continuum as either category, and suddenly switch from one category to the other somewhere in the middle. This will be reflected as a relatively clear cut-off point in the identification function. Figure 2 gives an idealised example of identification scores in a categorically perceived continuum (figure adapted from Newport 1982).

![Figure 2: Idealised categorical identification. The solid line represents the percentage of identifications as category A (step 1); the dotted line that as category B (step 10).](image)

In Figure 2, the graphs represent idealised identification scores for two categories, labelled A and B, whose canonical realisations are given as the extreme ends of the continuum, steps 1 and 10, respectively. The intermediate steps in the continuum will be unanimously judged to be instances of either category (100% A and 0% B or vice versa), except for a few steps around the crossover point between the categories (here steps 5 and 6), for which subjects will have wavering judgements. By contrast, identification of stimuli in a gradient continuum will result in a shallow function with much lower identification scores for the steps between the extremes.

In a discrimination task, subjects are asked to discriminate between pairs of...
stimuli that are adjacent in the continuum. The assumption is that a listener can only access distinctions between stimuli that function discretely in the language. Therefore, if perception is categorical, the difference between the stimuli in the pairs should be more easily perceptible at the crossover point between categories than elsewhere. As a result, discrimination rates should be much higher for pairs that straddle the boundary between the categories, and this peak in the discrimination function is expected to coincide with the cross-over point in the identification function, as shown in Figure 3 (dotted line; figure adapted from Newport 1982).

Figure 3: Idealised identification (solid line; identification as category B) and discrimination functions (dotted line; discriminated pairs) reflecting categorical perception in an acoustic continuum.

Figure 3 shows that, when perception is categorical in a given acoustic continuum, discrimination rates are lowest for steps that are identified as the same category, whereas steps that are not judged to belong to the same category are discriminated more easily.4

A number of questions have been raised about the validity of CP paradigm (cf. overviews in Newport 1982; Repp 1984; Harnad 1987; Massaro 1998). Although the perception of the classical phonemic contrasts between /b/, /d/ and /g/ has been found to match the predictions depicted in Figure 3 fairly closely (Liberman et al. 1957), it is doubtful whether vowels are perceived categorically in this way (Repp et al. 1979). Thus, it may be the case that Categorical Perception is not a prerequisite

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4 The 'baseline' values for the discrimination rates for the steps that are judged to belong to the same category depend to a large extent on the step-size. The function in Figure 3 represents a situation in which subjects cannot tell whether they are different, which results in random scores (50%). When a smaller step-size is chosen, subjects may never be able to discriminate between adjacent steps (0%). A situation in which discrimination rates are always higher than 50% indicates that all acoustic differences between the steps can be perceived to a certain extent, which may obscure the discrimination peak.
for all linguistic categories. Moreover, non-speech auditory continua show CP effects (e.g. Cutting and Rosner 1974), while speech sounds are also perceived categorically by animals (e.g. Kuhl and Miller 1975). These findings contradict the original assumption that only linguistically relevant discrete distinctions are perceived categorically.

Despite these objections, the paradigm has been applied with some success to differences in intonation contours (Kohler 1987; Ladd and Morton 1997; Remijsen and Van Heuven 1999, to appear). The obtained discrimination rates were rather low, but their peaks corresponded fairly closely with the crossover points in the identification functions. Yet, in intonation, phonologically non-contrastive differences might also show above-chance discrimination rates, as they may also be used to convey meaning differences. Evidently, such effects would obscure the CP results. In order to distinguish between phonetic and phonological differences, Gussenhoven (to appear) suggests that an undoubted categorical and an undoubted gradient difference should be included as experimental baselines to allow for comparisons with the hypothetical category. This is the approach adopted here.

**7.2.1. Method**

Three experimental continua, labelled A, B, and C, were designed to test the hypotheses that

I. differences in peak height in IP-final rises reflect a two-way categorical distinction between H*0% and H*H% (continuum A);

II. variation in timing and pitch direction in IP-final rises is gradient (continua B and C, respectively).

Two additional continua represented the experimental top-line (uncontroversial categorical contrast; continuum D) and the baseline (uncontroversial gradient variation; continuum E). In Figure 4, the experimental continua are given in the left-hand column, and the baseline continua in the right-hand column. The top two panels represent categorical differences, and in the bottom three panels variation is gradient.

The height of the peak in an IP-final rising movement was systematically varied in continuum A. The continuum was hypothesised to represent a phonological contrast (H*0% versus H*H%). In continuum B, the timing of the starting point of the rise was varied such that longer rises had shallower slopes. This means that the stimuli covered the phonetic continuum between early and late rises, which was hypothesised to be gradient. The purpose of continuum C was to test variation in the direction of the movement (level or rising), which was also hypothesised to be gradient. Top-line continuum D contrasted a final rising and a final rising-falling movement (i.e. H*H% versus H*L%). The rising part of the movement was identical to that in continuum C, but instead of continuing at the same level, fundamental frequency fell in the remaining part of the vowel. In baseline continuum E, peak height was systematically varied in a rising-falling movement.
Figure 4: The five continua of the CP experiment: experimental (left) and baseline (right); categorical (top) and gradient (bottom).

7.2.1.1. Materials
Three responses were elicited for each step (or comparison of steps) from each subject. Different utterances were used for the repetitions to increase the variety of the materials; they are given in (4).

(4) a. Mélanie vit normalement. ‘Melanie lives normally’
   b. Elle les avale oralement. ‘She takes them orally’
   c. On l’a ému moralement. ‘One has moved him morally’

As the experiment aimed at identifying linguistic cues conveyed by variations in pitch, the influence of all other factors had to be minimised. Firstly, a possible bias in the interpretation of the utterance by the lexical material used had to be avoided. That is, the utterances had to be equally acceptable in, for instance, a question context and an exclamation context, and they should not convey a specific attitudinal meaning. Secondly, the segmental structure had to meet a number of requirements to facilitate resynthesis and to make the fundamental frequency variations optimally
audible. The utterances were sonorant throughout, and high vowels and obstruents were avoided in the window that was to be manipulated in the five continua to minimise micro-prosodic fundamental frequency effects (e.g. consonantal perturbations; cf. Chapter 1 section 1.1.1). Also, the final two syllables were identical in the three utterances. Thirdly, the number of syllables and the location of the pitch accents was the same in the utterances to make them rhythmically as similar as possible. Because the preceding pitch movement may affect the judgement of the movement on the final syllable, the utterances had two pitch accents, and fundamental frequency on the stretch up to the second accent was always the same.

The utterances in (4) were recorded in the sound-treated studio of the Arts Faculty of the University of Nijmegen. The female speaker was selected to match the speakers of the corpora used in the analysis presented in chapters 5 and 6, i.e. an academically educated Parisian in her early twenties. She was instructed to try and produce a neutral reading of the utterances, to keep her voice as monotonous as possible, and only produce a slight rise on the two accented syllables. The most suitable recordings were selected from a number of repetitions to serve as the source for resynthesis. The selection criteria were naturalness of speaking rate, the absence of hesitations and creaky voice, similarity in pitch movement, in pitch range, in average pitch and in duration.

7.2.1.2. Resynthesis

The utterances were digitised at 16kHz and analysed by means of the software package PRAAT 3.8. (Boersma and Weenink 1996). Using the PSOLA technique, the utterances were resynthesised, changing their overall duration and their fundamental frequency contours to make them as similar as possible. Firstly, the utterances were slightly shortened, as shown in the top half of Figure 5 (Utterance (a): 88% of 1.63 sec. is 1.44 sec.; utterance (b): 93% of 1.41 sec. is 1.33 sec.; utterance (c): 90% of 1.45 sec. is 1.33 sec.). An exact match in duration between the three utterances could not be achieved, as the speaking rate of utterance (a) would have sounded higher than that of utterances (b) and (c). Secondly, the utterances were given the same fundamental frequency contour, which is shown in the bottom half of Figure 5. The dots in the fundamental frequency traces in the bottom panel of Figure 5 indicate the fundamental frequency values chosen for the resynthesis. All micro-melodic variation was suppressed, but the fundamental frequency traces closely resembled the original values produced by the speaker. The first fundamental frequency point, at 190 Hz, was located at the onset of voicing. The second, at 205 Hz, was introduced in the middle of the consonant of the first accented syllable in the utterance (/v/ /v/, and /m/, respectively). This meant that two minor changes were made with respect to the original utterances. Firstly, there was no fundamental frequency dip for the voiced fricatives in utterances (a) and (b). Although fundamental frequency is often lowered in voiced fricatives, which is clearly visible in traces (a) and (b) in Figure 5, the absence of this dip in the resynthesised versions did not seem to affect the naturalness of the contour.\footnote{The acceptability of the resynthesised utterances was evaluated by a native speaker. Moreover, several...}
Figure 5: Resynthesis procedure: duration and fundamental frequency were manipulated in the original utterances (top panel) to produce the source utterances for resynthesis in the five continua (bottom panel).

Secondly, the small peak produced on /nil/ in source utterance (a) (between fundamental frequency points 1 and 2) was removed in order to make the overall contours for the three utterances identical. This did not appear to affect the naturalness of the utterance either. The third point, at 245 Hz, was located at the end of the vowel of the accented syllable (/il, /al, and /yl, respectively), again in order to match the original fundamental frequency trace as closely as possible. The fourth fundamental frequency point was introduced to maintain the lowering in fundamental frequency towards /r/ in the source utterances.

Fundamental frequency points 1 to 4 were identical in all conditions. The stretch of speech following point 4 was the part that was to be manipulated differently in the five conditions, and therefore, point 5 was merely introduced as a time marker, indicating the point that was to be used for the final fundamental frequency value in the stimuli. Point 5 coincided with the point in time at which amplitude began to drop rapidly.\(^6\)

Fundamental frequency was systematically varied in ten steps, resulting in ten stimuli for each continuum. Three factors imposed limitations on the choice of step-

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Subjects asked whether the speaker had actually produced all the stimuli herself, which we take as a confirmation that the quality of the stimuli was good.

\(^6\) Initially, point 5 was placed at the offset of voicing, but as a result, pitch predictably sounded lower towards the end of the utterance-final accented syllable in some of the conditions.
size. First, the extreme ends of the continua had to be instances of the two contours at issue. In continuum D, for instance, the rising movement could not start any earlier, as this might induce the subjects to interpret the peak of the rising-falling movement as a marker of an additional secondary accent. Second, the experimental paradigm required the steps not to be too small, as differences that are too close to the threshold of perceptibility might lead to inconclusive results. Rossi (1971, 1978) investigated the absolute threshold of pitch change in French rising glides produced on vowels of 200 ms., 100 ms. and 50 ms. The thresholds he found were 19 Hz., 25 Hz. and 44.5 Hz., respectively. For a 200 ms. falling glide the threshold also occurred between 18 and 19 Hz., and the frequency of both rising and falling glides was perceived as the frequency value at approximately two-thirds of the vowel. Since in our experiment, the differences should not be too easily perceptible either - as this might obscure the peak in the discrimination function - the differences in this study were slightly smaller than Rossi’s. Third, the stimuli had to be acceptable to French listeners. In continuum A, for instance, a higher peak would have fallen out of the normal speaking range of the speaker. To this end, a native speaker evaluated the continua.

Figure 6 gives an overview of the fundamental frequency values in the stimuli of each continuum. In continuum A, the height of the peak of a 150 ms. rising movement was varied from 250 Hz. to 385 Hz. in 10 steps of 15 Hz. In continuum B, the length of a 50 ms. final rising movement from 195 Hz. to 270 Hz. (i.e. 75 Hz.) was increased in steps of 25 ms. Thus, a 75 Hz. rise is systematically lengthened from 50 to 275 ms., as shown in Figure 6. In continuum C, the length of the 75 Hz. rise was held constant, but its starting point was varied in 10 steps of 10 ms. from 100 to 190 ms., and the fundamental frequency continued at 270 Hz. until the end of the Intonation Phrase. The rising part of the movement in continuum D was identical to that in continuum C, but instead of staying level, the remaining part of the vowel was filled by a fall with a constant slope but with varying duration and end point (step-size 10 Hz.). In Continuum E, peak height was systematically varied in 10 steps of 10 Hz. from 250 Hz. to 340 Hz. The timing of the rising-falling movement was identical to the extreme end of continuum D (i.e. a 100 ms. rise followed by a 90 ms. fall).

7 The Just Noticeable Difference in stimuli below 800 Hz. is only 1 or 2 Hz. (Slis 1996). However, as ’t Hart (1981) points out, it is unlikely that such small differences are relevant to the perception of speech. On the basis of an investigation of the relative prominence of pitch movements, ’t Hart (1981) concludes that a difference of approximately 3 ST (approximately 60 Hz. in our stimuli) is required for most listeners to perceive a difference in prominence, but according to Rietveld and Gussenhoven (1985) a much smaller difference of only 1.5 ST (approximately 20 Hz.) suffices.

8 For variation in F0 the Herz scale was chosen in this experiment rather than the Semitone scale or the ERB-rate scale (equivalent rectangular bandwidth). Rietveld and Gussenhoven (1985) established that prominence judgements of different excursion sizes follow the Herz scale more closely than a Semitone scale, but the ERB-rate scale has subsequently proved to give even better results (Hermes and Van Gestel 1991). The Herz scale was adopted, however, because our analysis programme allows immediate specification in Herz, and the difference between ERB and Herz was unlikely to make a difference for our results.
Figure 6: Overview of the stimuli produced in the five continua of the experiment.

An example of a stimulus resulting from these manipulations is given in Figure 7.
Figure 7: The Praat analysis window, with the result of the resynthesis procedure for *Mélanie vit normalement* (continuum D step 10).

7.2.1.3. Procedure
In the identification task, the five continua were presented separately. That is, the subjects first identified all stimuli in Continuum A, then all those in Continuum B, and so forth. The stimuli in each block were randomised, and introduced by an anchor in which the two extremes of the continuum were presented once, with a 600 ms. interval. The anchor was repeated after every 10 stimuli. Every stimulus was repeated after 600 ms., and each pair was followed by a 3 sec. silent interval, in
which the subjects recorded their judgement on the score form. The tape had a total
duration of almost 26 minutes. This version was presented to half of the subjects. On
the test tape presented to the second half of the subject group, the order of the five
continua and that of the stimuli within each continuum were reversed to control for
order effects.

Each continuum was introduced by a practice block, in which the subjects were
made familiar with extreme ends of the continuum. First, step 1 was repeated three
times, followed by three repetitions of step 10. Second, the two stimuli were
presented pair-wise, again three times. In the third part of the practice block, the task
was practised by means of four stimuli, two of which represented the extreme ends of
the continuum, and two represented intermediate steps 2 and 8. After responding to
the third series, the subjects received feedback on their performance. On the score
form, subjects had to give a forced choice response by crossing the box labelled A or
B. Every page started with an anchor before a new block of ten response boxes. The
subjects were told that the instances of A and B had not been distributed evenly over
the tape, and that therefore, they could encounter sequences of stimuli for which they
might want to give the same judgement. The first two pages of the score form, which
cover the instructions and the beginning of the test, are included in Appendix E.

In the discrimination task, subjects were asked to judge the similarity of the
members of a pair of stimuli that were immediately adjacent in the continuum. As
there were nine comparisons for each of the five continua, which were replicated on
three utterances, this part of the experiment contained a total of 135 experimental
pairs. A test tape with a total duration of 26 minutes was prepared. On the tape, the
stimuli were randomised such that there were never more than two consecutive pairs
from the same continuum, and every stimulus pair was immediately repeated in the
reverse order. This unconventional method of presentation was chosen on the basis
of the poor results of a pilot test, in which stimulus pairs were presented in the
conventional AX format (i.e. the test stimulus X immediately follows the standard
A). 9 The four subjects that participated in this version of the discrimination task
heard hardly any differences in the experimental pairs at all.10 We therefore decided
to immediately repeat the stimulus pair, as this made the contrast between the steps
more salient. The silent interval between the members of each pair and its repetition
was 500 ms., followed by a 3 sec. silent interval in which the subjects recorded their
judgement. After five stimulus pairs, a warning tone was inserted to help the subjects
keep track of their judgements on the score form. Half of the subjects in the group
listened to this version of the experiment, and the other half to a second test tape on
which the order of the stimuli was reversed (also within pairs), again to control for
order effects.

A practice session of six stimulus pairs was included to make subjects aware of

9 In the pilot test, 22 pairs in which the stimuli were identical, and 23 pairs in which the stimuli were
more than one step apart, were added. The stimuli were presented in such a way that within each block of
ten pairs, seven pairs were experimental pairs, and three pairs were control pairs and fillers (one or two of
each). Apart from this constraint, the order of presentation of the stimuli was completely random.
10 The subjects indicated that this made them feel rather frustrated.
range of differences they could expect to encounter. Halfway through the test the subjects took a break of approximately fifteen minutes, and for this purpose, a second practice block was included at that point. On the score form, subjects had to give a forced choice response by crossing the box labelled identique 'identical' or différent 'different'. The subjects were instructed to cross the box labelled différent 'different' whenever they thought they perceived a difference during either the first or the second presentation of the stimulus pair. Every page started with a new block of five stimuli. An extract of the score form is given in Appendix E.

The DAT-tapes were presented over headphones in a quiet room to maximally three subjects per session. The experiment started with the identification task, which was followed by a twenty-minute break.

7.2.1.4. Subjects
Eighteen academically trained native speakers from the north of France (12 from Paris) participated in the experiment. All but one were in their early twenties. They were recruited from the student population of the universities of Paris III and Nijmegen. The latter subjects were exchange students, and most of them had arrived in The Netherlands up to three weeks prior to the experiment. No hearing difficulties were reported, and they were paid a small fee.

7.2.1.5. Predictions
Continuum D functions as the top-line condition of the experiment. Here, a clear crossover point between the categories is predicted to occur in the identification scores, which coincides with a peak in the discrimination rates. The results for the A continuum should reflect those for the D continuum, as a similar categorical distinction is predicted to apply. In continua B, C and E, however, the stimuli are predicted to be gradiently different from each other. That is, there are no clear categorical distinctions, and therefore, the change in the identification scores from step 1 to step 10 should be more gradual. Overall, the discrimination rates should be lower than those in continua A and D, and although pairs of stimuli are still expected to be perceived as different, there should be no clear peak in the discrimination rates.

7.2.2. Results
7.2.2.1. Identification
Identification scores are shown in Figure 8 as the percentage of times subjects identified a stimulus as step 10, with the experimental continua on the left and the baseline continua on the right. The top two panels present the results for the hypothesised and undoubted categorical continua; the three bottom panels present the continua with gradient variation.
Figure 8: Percentages of identification as step 10 in the five continua; scores are pooled over subjects and repetitions (total number of observations is 2700).

In order to enable comparisons between the continua in a statistical analysis, the identification data were transformed into probit functions, and regression lines were fitted to the transformed values (Finney 1971). The slopes of the regression lines of each continuum were compared with those of every other continuum in a series of t-tests, reported in Table 1.\footnote{Regression lines were fitted to the identification data and to their transformed probit values. In continua B and E, where identification rates vacillate, the linear regression lines did not fit the data very well (B: $\chi^2=18.25$, $p<0.05$; E: $\chi^2=17.06$, $p<0.05$). This means that the results for t-tests involving these continua are unreliable. The statistical analysis of the comparisons between the Points of Subjective Equality of the continua is not reported, since their location in the continuum depends on the choice of extremes and step-size, and similarities between them would therefore be coincidental.}
Table 1: T-test results of the comparisons between the identification functions of the continua.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>T-value</th>
<th>Significance</th>
<th>Comparison</th>
<th>T-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; B</td>
<td>37.86</td>
<td>p&lt;0.0001</td>
<td>B &amp; D</td>
<td>72.16</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>A &amp; C</td>
<td>10.59</td>
<td>p&lt;0.0001</td>
<td>B &amp; E</td>
<td>20.06</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>A &amp; D</td>
<td>3.80</td>
<td>p&lt;0.01</td>
<td>C &amp; D</td>
<td>11.02</td>
<td>p&lt;0.0001</td>
</tr>
<tr>
<td>A &amp; E</td>
<td>7.19</td>
<td>p&lt;0.0001</td>
<td>C &amp; E</td>
<td>0.65</td>
<td>n.s.</td>
</tr>
<tr>
<td>B &amp; C</td>
<td>38.74</td>
<td>p&lt;0.0001</td>
<td>D &amp; E</td>
<td>6.26</td>
<td>p&lt;0.0001</td>
</tr>
</tbody>
</table>

The analyses revealed that all identification functions were significantly different from each of the other continua, except for those of continua C and E. In other words, only the shapes of the curves for continua C and E are comparable.

The latter finding could be interpreted to indicate that continuum C is gradient, as was hypothesised. As in baseline continuum E, its identification function does not show the sharp crossover point that characterises categorical perception, and not even the extremes of the continua are always correctly identified. The identification function of the other hypothesised gradient continuum B has the same characteristics (see Figure 8), but it is significantly different from continua C and E. This may be due to a different degree in vacillation in the identification rate (see in particular the scores for steps 8 to 10). Nevertheless, the identification function strongly suggests that perception cannot be categorical in continuum B either.

The identification functions of the hypothesised categorical continuum A and the continuum with the undoubted phonological contrast (D) were significantly different as well. This means that the results for the top-line continuum cannot be used to evaluate categorical perception in the hypothesised contrast. In fact, identification in continuum D does not indicate categorical perception at all, as can be seen in Figure 8. The function is shallow and unstable, and even the extremes of the continuum are not always correctly identified, just as in the gradient continua. By contrast, identification in continuum A appears to confirm our hypothesis of a categorical contrast. The identification function shows a rather sharp crossover point and seems stable, and identification towards the extremes of the continuum reaches 100%.

7.2.2.2. Discrimination

Figure 9 gives the pooled scores for the discrimination task as percentages of perceived differences between the adjacent pairs. A repeated measures analysis of variance (SPSS MANOVA), performed for each continuum separately with as fixed within-subjects factor PAIR (9 levels), revealed a significant main effect for continua A, C and E (Huyn-Feldt corrected F for A: F_{7.13,121.23}=6.16, p<0.0001; for C: F_{7.04,119.62}=3.41, p<0.001; and for E: F_{7.52,127.82}=3.01, p<0.01; Rietveld and Van Hout 1993). That is, the stimuli of some pairs were discriminated significantly better than other pairs in continua A, C and E. In continuum B, the apparent discrimination peak for pair 4-5 was not sufficiently high, and in the saw-tooth pattern of discrimination in continuum D, there was too much variability for any one pair to stand out
significantly. This means that the discrimination results potentially reflect categorical perception in continua A, C and E only.

![Graphs of discrimination results in continua A, B, C, D, E](image)

**Figure 9:** Percentages of discriminated pairs in the five continua; scores are pooled over subjects and repetitions (total number of observations is 2430).

However, as an inspection of the graphs in Figure 9 shows, none of the continua show a single clear peak in discrimination, which may be interpreted as sufficient evidence for the absence of a single category boundary. Yet, possibly, one of the peaks coincides with the crossover point in the identification function, in which case the requirement for categorical perception of a relation between the two functions would be met. In Figure 10, the identification and discrimination functions are plotted for all continua with the Point of Subjective Equality, which was estimated from the probit functions that were fitted onto the identification data.
Figure 10: Comparison of the identification and discrimination functions in the five continua, with PSEs added.

Clearly, the PSEs in continua A and E, where differences in discrimination were significant, do not coincide with any discrimination peak. As a consequence, the functions cannot be assumed to be related. Figure 10 also shows that in the other continua, the PSEs do seem to be located near a peak. As the presence of the peaks in continua B and D was not confirmed in the statistical analysis, the coincidence cannot serve as evidence for categorical perception in these continua. The situation might be different in continuum C, where a significant main effect was found. A post-hoc analysis was performed on the data in continuum C in order to verify whether the significance of the main effect could be attributed to a specific pair or pairs (Tukey's HSD, significant at the 5% level). The analysis revealed that the data fell into two subsets: (1) all pairs except pair 3-4, and (2) all pairs except pair 7-8.
This finding indicates that discrimination is indeed better for pair 3-4. Since this pair roughly coincides with the PSE of the identification function, the data for continuum C appear to meet the requirement of a relation between the identification and discrimination functions. Nevertheless, the fact that the subset with the peak (3-4) only excludes one pair (7-8) indicates that discrimination rates vacillate considerably, which conflicts with the CP requirement that discrimination is better at the category boundary than at any other point.12

7.2.2.3. Consistency in the judgements
Since the data do not yield decisive evidence for categorical perception, we decided to further explore the identification scores to see whether consistency in the judgements might reveal any differences between the continua. The assumption underlying the analysis was that more consistent judgements indicate that listeners are better able to identify a stimulus, which increases the likelihood that the stimuli in the continuum fall into different categories. This hypothesis was operationalised in three different ways: (1) as absolute consistency, (2) as weighted consistency, and (3) as vacillation.

(1) The absolute consistency index. The first measure of consistency was calculated by counting the number of inconsistent judgements for each set of three stimuli. That is, subjects gave three judgements for each step of the continuum, and the steps for which not all three judgements were the same were counted. This resulted in a value ranging from 0 to 10 for each subject, where 0 represents an immediate shift in identification and 10 no consistency for any step at all. Thus, the absolute consistency index reflects wavering judgements for all steps of the continuum. For truly gradient continua, the index should have a relatively high value, and low values could indicate categorical perception. However, as the index does not differentiate between inconsistencies around the crossover point in the continuum and the extremes of the continuum, low values are not necessarily indicative of a categorical distinction. Therefore, a second index assessed consistency while taking the location of a stimulus relative to the extremes of the continuum into account.13

(2) The weighted consistency index. From the extreme ends of the continua, the steps with consistent judgements were identified for each subject, but only consistent steps that appeared in an uninterrupted sequence from either extreme were counted. For instance, when a listener had the same judgement for the three repetitions of steps 1, 2, 3, 6, 9 and 10, the count was 3 + 2 = 5. The resulting number was subtracted from 10 to give the value for the weighted consistency index. Thus, the index reflects how suddenly each listener changes his mind about the identity of the stimuli in a continuum. Although the weighted consistency index allows us to

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12 The post-hoc analysis was also performed for continua A and E to verify our informal observations. In continuum A, the data fell into four subsets, reflecting the sudden decrease in discrimination for pair 2-3 and the overall decreasing rates from pair 3-4 onwards. Thus, the effect of PAIR could not be attributed to any one point. The data in continuum E fell into two subsets which did not share pairs 4-5 and 9-10. That is, discrimination was significantly better for pair 4-5 and worse for pair 9-10.

13 Since the absolute number of inconsistencies is not reflected in the weighted consistency index, only the combined results of the indices can give a reliable evaluation of consistency in the judgements.
distinguish between steep and shallow identification functions, it does not indicate whether the scores increase progressively from step to step, which is the second prerequisite for categorical perception. Therefore, a third index was calculated which quantified how often the changes of mind occurred.

(3) The vacillation index. For the third index, all changes from three identifications as step 1 to three identifications as step 10 were assigned the value 1, and intermediate changes were counted as 1/3. A hypothetical example of the calculation of the vacillation index is given in Table 2.

Table 2: Example of the calculation of the vacillation index.

<table>
<thead>
<tr>
<th>Steps</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judgements as 1</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Judgements as 10</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Vacillation index</td>
<td>0 + 1 + 1 + 1/3 + 1/3 + 1/3 + 0 + 1/3 + 1/3 = 3.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

As can be seen in Table 2, a transition of judgement ‘step 1’ to ‘step 10’ is assigned the same value when it occurs in one step as when it involves three steps. This means that a high value for the index reflects a saw-tooth pattern in the listener’s identification curve.

The mean values for the three indices are given in Figure 11. The analyses of variance (SPSS ONEWAY) which compared the five continua for consistency as expressed by each index revealed significant main effects for the absolute and the weighted consistency index (F_{4,85}=2.66, p=0.013 and F_{4,85}=3.39, p=0.038), but the vacillation index showed no significant differences.\(^{14}\) The post-hoc analyses revealed for both consistency indices that the effects could be attributed to a significant difference between continua A and C (p<0.05). The indices show that the judgements were most consistent in continuum A, where different peak heights in a final rise were identified. Not only is the mean value of the index lower, but the variance is also much smaller than that in the other continua. Subjects performed worst in continuum C, where a rise with a constant slope was followed by a stretch of level pitch of varying length. This means that the significant differences between continuum A and C confirm our hypothesis that variation in the former continuum is discrete and that in the latter gradient. The subjects’ performance in the undoubted categorical continuum D, however, is not significantly different from that in any of the others. Surprisingly, its values for all three indices, as given in Figure 11, match those for the undoubted gradient continuum E very closely.

\(^{14}\) The Levene statistic was 4.12 with p<0.01 and 5.70 with p<0.001, respectively. This means that the F-values may in fact not be significant at the 5% level, i.e. they may not be significant at all. However, this is unlikely to be the case for the absolute consistency index, since p was close to 0.01. In other words, the results for the weighted consistency index may not be reliable.
Figure 11: Consistency in the judgements, expressed as the mean value over subjects for (1) the absolute consistency index (top), (2) the weighted consistency index (centre), and (3) the vacillation index (bottom; error bars are included, and the total number of observations for each index is 90).
7.2.3. Conclusion

The Categorical Perception data do not provide decisive evidence for our hypotheses that (I) differences in peak height in IP-final rises reflect a two-way categorical distinction between H*0% and H*H% (continuum A), and (II) variation in timing and pitch direction in IP-final rises is gradient (continua B and C). Although the identification scores for the hypothesised categorical continuum A appeared to reflect categorical perception, the cross-over point in the identification function did not coincide with a peak in the discrimination function. The results for the other continua all point towards gradient variation. The identification functions did not show a sharp crossover point, identification rates vacillated, and not even the extremes of the continua were always identified correctly. In the discrimination functions, either the differences between the pairs were not significant, or none of the discrimination peaks coincided with the crossover point in identification. This means that top-line continuum D, in which variation is undoubtedly categorical, does not show any of the expected categorical perception effects, and as a consequence, it unclear whether the results for the experimental continua are reliable. The poor results for the top-line continuum may indicate either that the intonational contrasts investigated are not in fact perceived categorically, or that the CP paradigm was not applied correctly.

Firstly, the basic assumption that perceived variations in pitch reflect phonological categorisation may be incorrect. The fact that the identification and discrimination functions were unrelated in our experiment implies that the identification results were task-induced. That is, the identification paradigm forces subjects to assign a stimulus to one of two categories, and possibly, they based their judgements on the acoustic properties instead of only the linguistically relevant properties of the stimulus. If so, the paradigm measured differences in auditory processing, and the results were merely an artefact of the forced-choice response task (see Newport 1982; Harnad 1987; Massaro 1998 for a discussion). For instance, regardless of their linguistic function, acoustic differences in a fundamental frequency peak may simply be more salient than those in the timing of a valley. The relatively abrupt shift in the identification function in continuum A could be interpreted to merely indicate that the task was easier to perform here than elsewhere. A similar effect may also have induced the poor results for the undoubted categorical continuum D, which contrasted rising and rising-falling movements. Possibly, 't Hart's (1981) finding for Dutch that differences in falling movements are more difficult to perceive than differences in rising movements also applies to French. If this is indeed so, the differences in continuum D can be expected to be less salient than those in the other continua. In that case, there is no point in comparing the results of the various continua, and the CP paradigm cannot be applied fruitfully.15

15 In addition, resynthesis may have affected the acoustic properties of the final syllable in different ways in the continua.
A second possible explanation for the poor results in continuum D is that instead of two categories whose canonical realisations were situated at the extremes of the continuum, the continuum had in fact a third category somewhere in the middle of the continuum. If so, the greater number of wavering identification judgements could be explained by the paradigm, which forced listeners to identify each step as one of two categories instead of three. However, the discrimination function should then show two clear peaks (marking the boundaries between the three categories), which is not the case.¹⁶ In view of this fact, it is unlikely that an identification paradigm with three response categories would give better results.

The third explanation for the poor results in the categorical continua is that the discrimination paradigm was not applied correctly. That is, the unconventional way in which the stimuli were presented in the discrimination task may have obscured the results. Instead of applying the well-established paradigms AX, ABX, or 4IAX (Repp 1984), AX was immediately repeated in the reversed order (AXA), which may have resulted in adverse effects.¹⁷ Also, pairs in which the stimuli were more than one step apart were not included. However, it is unlikely that a different method of presentation would have eliminated the characteristics of gradient perception in the two (hypothesised) categorical continua (i.e. the overall decreasing discrimination rates in continuum A and the saw-tooth pattern in continuum D). We therefore conclude that a discrimination task may simply not be suitable for the investigation of the intonational contrasts tested here.

In sum, the rather good identification performance in continuum A could at best be interpreted as an indication that differences in peak height in final rises are categorical, and the consistently poorest performance in continuum C suggests that the difference between rising and rising-level pitch is gradient.

7.3. Experiment II: Contrastive judgements of attitudinal meanings

The aim of the experiment reported in this section was to establish whether gradient variation can be used to contribute to the attitudinal or emotional interpretation of the final rise. That is, can phonetic variation that does not derive from a phonological contrast be shown to (slightly) change the meaning of the movement? For instance, the timing of the dip in the final rise – which is phonologically non-contrastive in the analysis of Chapter 6 – may be found to lead to gradationally different interpretations. Thus, an earlier timing in a question rise, as in (5), might be found to increase the likelihood of a surprised interpretation.

¹⁶ Four peaks are visible in the discrimination rates, of which two seem higher than the others, but the differences are not significant (Figure 9).

¹⁷ In AX, the test stimulus X immediately follows the standard A; in ABX either A or B is repeated as the test stimulus, and in 4IAX, X is embedded in a series of repeating standards A.
AN EXPERIMENTAL INVESTIGATION OF FINAL RISES

If gradient variation is found to be meaningful, the finding would help to explain the confusion in the literature about the grammatical status of the differences in French final rising movements.

A semantic task was applied to a subset of the stimuli that were used in the first experiment. The experiment investigated (1) whether in French final rises, gradient variation can affect the attitudinal or emotional interpretation of the tonal morpheme, and (2) what the effect of this gradient variation is.

7.3.1. Method

The influence of fundamental frequency variation was investigated in continuum B (dip timing) and D (contrast between rising and rising-falling movements) by means of contrastive judgements of attitudinal meanings. A number of attributes, listed in (6), were evaluated for suitability.

(6) Involvement: las, indifférent, engagé, enthousiaste
    Command: aggressif, pêremptoire, autoritaire, poli, soumis
    Certainty: incertain, douteux, confiant, sûr
    Persuasion: incrédule, convaincu, étonné

With the help of a native speaker, étonné ‘surprised’ and sûr ‘certain’ were chosen, because they were most likely to reveal interesting differences between the continua.

We hypothesised a strong effect for sûr in continuum D, where the rising movement at one extreme can signal continuations or questions, and the rising-falling movement at the other assertions. The effect for étonné was expected to be much weaker, as neither extreme appeared to convey strong surprise. Since the variation in continuum B was hypothesised to be non-contrastive, overall weaker results were expected for this continuum. We had no hypothesis about the effect of sûr in continuum B, as the claims in the literature about the pragmatic meaning of the timing of the dip were somewhat contradictory. For étonné a stronger effect was expected for an early timing.

Four steps (1, 4, 7 and 10) were selected to create 16 stimulus pairs in each continuum. Each step was combined with every other step in both directions (AB and BA), and with itself (AA). The stimulus pairs were randomised such that the same pair appeared maximally twice in succession. The silent interval between pairs was 3 sec., and that between the members of each pair 500 ms. After six stimulus pairs, a warning tone was inserted. The total duration of the tape was just over 26
Relative judgements on a rating scale are the most appropriate in this type of experiment, but as subjects in a pilot experiment reported to have great difficulty in establishing which stimulus sounded the more certain or surprised, a rating task was deemed to be too difficult. Also, they objected to giving forced choice responses (as identical pairs had been included), and therefore a third response category ‘identical’ was added. Subjects were instructed never to use this option when they thought they heard a difference between the stimuli. Half of the subjects were first asked to indicate for each pair in which stimulus the speaker sounded more sure of herself. Then, they listened to the same pairs again to assess the speaker’s surprise (instructions and layout of the score form can be inspected in Appendix E). A second order of presentation was created in which the semantic scales and the stimulus pairs were reversed, which was played to the other half of the subjects. The DAT-tapes were played in a quiet room over headphones.

In addition to the eighteen subjects of the Categorical Perception experiment, four more subjects participated in the second experiment. As before, they were students, aged between 20 and 30, they came from the north of France, and they were paid a small fee.

7.3.2. Results

The data were analysed by means of the analysis of variance for paired comparisons, developed by Scheffé (1952). Separate analyses were performed for each scale in each continuum (VERANOVA). The analysis yields an interval scale with the positions of the steps, and a yardstick with which the significance of the distance between these positions can be assessed. The positions of the steps are given in Figure 12.

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18 For two reasons, the assumptions of Scheffé’s analysis are not met. First, we did not use a rating scale with minimally seven categories, and subjects gave three judgements for each stimulus pair. It is unclear to what extent this affects the reliability of the results of the statistical analyses. However, as an inspection of the raw data clearly showed the same effects as the ones reported here, and the exact size of the differences between steps is not crucial to our hypotheses, this does not invalidate our conclusions.
Figure 12: Contrastive judgements of sūr (solid line) and étonné (dotted line) in continuum B (top) and continuum D (bottom). The value for each step represents Scheffé's estimate (the total number of observations is 4224).

Figure 12 shows that in both continua, sūr and étonné have opposite effects. The analyses of variance revealed significant main effects for both attributes on both scales, reported in Table 3.
Table 3: Results of the analyses of variance for each continuum and attitudinal meaning (Scheffé).

<table>
<thead>
<tr>
<th>Continuum</th>
<th>Attribute</th>
<th>Main effects</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>sûr</td>
<td>$F_{3.789}=3.71$</td>
<td>$p &lt; 0.05$</td>
</tr>
<tr>
<td>B</td>
<td>étonné</td>
<td>$F_{3.789}=27.67$</td>
<td>$p &lt; 0.05$</td>
</tr>
<tr>
<td>D</td>
<td>sûr</td>
<td>$F_{3.789}=106.41$</td>
<td>$p &lt; 0.05$</td>
</tr>
<tr>
<td>D</td>
<td>étonné</td>
<td>$F_{3.789}=14.98$</td>
<td>$p &lt; 0.05$</td>
</tr>
</tbody>
</table>

This means that a late timing (step 1 in the left-hand panel of Figure 12) sounds significantly more assured and less surprised than an early timing (step 10). The stronger effect that can be observed for continuum D (right-hand panel) is also significant. That is, when rising movements are compared with rising-falling movements, the rise (step 1) sounds less assured and more surprised. The distances between the steps on the interval scale were evaluated by means of the yardstick. Table 4 summarises the results of this analysis.

Table 4: Significant differences between the steps for each attitudinal meaning provided by the yardstick.

<table>
<thead>
<tr>
<th>Continuum</th>
<th>Attribute</th>
<th>Significant differences between steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>sûr</td>
<td>1&amp;10</td>
</tr>
<tr>
<td>B</td>
<td>étonné</td>
<td>1&amp;7, 1&amp;10, 4&amp;7, 4&amp;10</td>
</tr>
<tr>
<td>D</td>
<td>sûr</td>
<td>all steps</td>
</tr>
<tr>
<td>D</td>
<td>étonné</td>
<td>1&amp;7, 1&amp;10, 4&amp;10, 7&amp;10</td>
</tr>
</tbody>
</table>

The top row of Table 4 shows that the difference between early and late timings of the rise is only significant for sûr when the extremes of the continuum are compared. This is not the case for the judgements of étonné, where the results reflect the greater difference between the estimates of steps 4 and 7 than that between steps 1 and 4, and 7 and 10, visible in Figure 12. The much stronger effect for sûr in continuum D results in significant differences between all steps, and the results for étonné reflect the almost linearly decreasing, but somewhat smaller effect for surprise in this continuum.

7.3.3. Conclusion

The results of the semantic task confirmed our hypothesis of a strong effect for sûr in continuum D, and that elsewhere the effects are weaker. The attitudinal meanings had opposed effects in each continuum. The rising-falling movements of continuum D sounded more assured than the rising movements, as predicted, and the reverse was the case for perceived surprise. Within rises, an early timing of the dip sounds less assured and more surprised than a late timing, as the results for continuum B show. This finding ties in with Mertens’ suggestion that continuation rises with a late timing sound more affirmative (Mertens 1992).
A possible explanation of these findings is provided by Ohala (1984), who relates similarities in the use of fundamental frequency variation in the languages of the world to ethological differences in body size. More specifically, he argues that high acoustic frequency generally signals the primary meaning 'small vocaliser', leading to secondary meanings such as subordinate, non-threatening, etc., whereas low frequency signals 'large vocaliser', associated with meanings such as dominant, aggressive, threatening, etc. These tendencies are reflected, among other things, in similarities in the signalling of attitudes or emotions, and of sentence types, according to Ohala. Thus, when people express attitudes or emotions such as deference, politeness, and lack of confidence, they tend to use high and/or rising fundamental frequency, but when they express assertiveness, authority, aggression, confidence and threat, it tends to be low or falling. Also, cross-linguistically, questions are often marked by high and/or rising fundamental frequency, and in statements it is often low and/or falling. Our results for the contrast between the rising-falling and rising movements could be interpreted to reflect a similar functional difference in French, the rising movements sounding more surprised and less assured than the rising-falling movements.

Our findings for the timing of the dip in final rises indicate that attitudinal meaning changes slightly when the rise is longer. Although the range of the rise was constant in our experiment, in longer rises, higher pitch can be perceived for a longer period of time. Following Ohala, this can be said to decrease the degree of certainty and increase the degree of surprise expressed.\(^\text{19}\) Thus, the finding suggests that variation in the timing of the dip can be used to signal different degrees of assertiveness, and is therefore meaningful. However, the effects were much weaker here than in the categorical condition, in particular for sùr. We conclude therefore that the timing difference is unlikely to be sufficiently salient to cue a categorical contrast.

7.4. Discussion

A meaningful evaluation of our hypotheses about discreteness in fundamental frequency variation in final rises could not be made on the basis of the undoubted contrastive and gradient continua introduced in the Categorical Perception experiment. The poor results for the top-line continuum D (rising versus rising-falling movements) may be interpreted to indicate that the differences were perceived continuously. Also, the similarity of the results for the top- and baseline continua (gradient variation in peak height) suggests that differences in peak height are more easily detectable than differences between rising and rising-falling movements. If so, the subjects' performance may be the result of auditory processing instead of categorisation in speech. These findings appear to confirm that categorical perception cannot be a prerequisite for phonological category membership in

\(^{19}\) Also, a bigger range in final rises has been claimed to signal more surprise (Faure 1972 for French; Van Bezooijen 1984 for Dutch).
intonation. This means that an imitation task may be applied more successfully in the investigation of intonation categories (cf. Pierrehumbert and Steele 1989; Remijsen and Van Heuven to appear; see Gussenhoven to appear for discussion).

Although the experiment can therefore not provide decisive evidence for our phonological analysis, the findings for the experimental continua indicate that the analysis is very likely to be correct. The overall strongest effects in continuum A and the weak effects for the other continua support a categorical contrast between H*0% and H*H% which is primarily based on peak height.

The findings of the semantic task establish that variation in the timing of a rise has an effect on the interpretation of the utterance, which may explain why there is so little consensus about the analysis of final rises. Yet, the semantic effects were overall much stronger for the continuum with the well-established contrast (D) than for the experimental continuum (B), and this is exactly what one would expect to find when variation in timing is indeed gradient. Such relative differences in the pragmatic contribution of gradient and discrete variation could easily be accounted for in a phonological model that distinguishes between a phonetic level, where gradient variation can serve to convey subtle meaning differences, and a phonological level, where variation functions contrastively. Thus, the findings provide additional support for our view that a description of French intonation should distinguish between different levels of representation.
Chapter 8  Summary and conclusion

8.1. Introduction

This study provides an account of the tonal structure of French intonation contours and their association with the segmental structure. Controversies persist about both aspects of French intonation in the literature. First, descriptions disagree about the number of distinct contours. Although there is a general consensus that falling, rising and rising-falling pitch movements function contrastively at the end of an utterance, conflicting claims have been made about the existence of further contrasts at the end of utterances and in non-final position. Second, there is no agreement about the way in which intonation contours associate with the text. For some, intonation contours are holistic units that each have their own domain (Rhythmic Groups or Sense Groups, sometimes contained in higher-level Intonation Groups). For others, stressed syllables and/or domain boundaries serve as anchors for the turning points of the contours. The issues are closely related, because the way in which the association between contours and text is described determines how intonational contrasts are defined. That is, they are primarily defined by the direction of changes in pitch (falling, rising or level), or by the location of these changes (high and low turning points). As a consequence, different distinctions between intonation contours are made and different predictions about where the distinctions can occur.

This study aims to show that these controversies can be resolved when intonation contours are analysed as strings of phonological High and Low tones, which associate with metrically strong syllables (T*) and Intonation Phrase boundaries (T%). At the phonetic level, the tones are implemented as targets, which are connected through phonetic transitions to form the surface melodic contour. An inventory of two pitch accents and five boundary specifications restricts the number of contrastive intonation contours that can be generated. Since phonological tones are distinguished from their phonetic implementation, one intonational category can have a range of realisations, but crucially, the description makes clear predictions about the nature of the difference between any intonation contours, i.e. categorical, or gradient within some category.

Thus, the present description states unambiguously which variations in pitch function discretely (what is phonetic, what is phonological), and its claims can be experimentally verified.

Our description of the association between the pitch accents and the text further restricts the intonation contours that can be generated. The proposal describes how a number of factors, such as the adjacency of stressed syllables and the morphosyntactic structure of the utterance interact to determine which metrically strong syllables actually surface with a pitch accent. The distribution of pitch accents is described by a number of universal well-formedness constraints, such as NOCLASH...
(two immediately adjacent accented syllables are prohibited) and RIGHTMOSTPWD
(Prosodic Words must have final accents), which are ranked relative to each other in
the grammar. The surface form that best satisfies the higher-ranked constraints is the
one that is selected (e.g. de jolis airs ‘pretty tunes’ is better than de jolis airs; the
underlined syllables are accented). However, the description specifies that some
constraints are not ranked relative to each other, and therefore, more than one form is
selected in some cases (e.g. de jolis airs is also acceptable). Thus, the description
accounts for variation in phrasing and accentuation, but excludes ungrammatical
forms.

The study thus offers testable hypotheses about the phrasing that is relevant to
intonation contours. Since this phrasing is shown to determine the locations at which
contours change direction, it is clear that the issue of association of contours to text
is decided in favour of an analysis in which boundaries as well as stressed syllables
define the anchor points of the contour.

In the following sections, the findings reported in the preceding chapters will be
summarised, and the limitations and the implications of the study will be evaluated.

8.2. Summary

8.2.1. Introduction

Chapters 1 and 2 are introductory. The main starting point of the study is that
intonation is phonologically structured. Melodic changes are assumed to occur
around accented syllables and major boundaries (e.g. at the end of an utterance), and
primarily involve differences in the direction and timing of pitch. Since the aim of
the study is to describe the phonological structure of French intonation, it needs to
establish which changes function contrastively.

In chapter 1, it is made clear that an answer to this question requires not just an
analysis of the contrastive pitch variations of the language, but also of the phrase
structure which determines where these variations begin and end. Chapter 2
introduces the theoretical background of the study by discussing the models which
have been applied to French intonation in previous studies, and by comparing them
with the Autosegmental-Metrical approach, which is adopted here.

8.2.2. The distribution of pitch accents: The data

In Chapter 3, evidence is presented that the Phonological Phrase as defined in
Prosodic Phonology conditions the distribution of pitch accents in French. This
distribution is determined by two phenomena, the grouping of words into a domain
traditionally referred to as the Rhythmic Group or Sense Group, and the resolution of
clashes between directly adjacent accents, referred to as Clash Resolution. First, if
we abstract away from situations in which stress clash occurs, the distribution of
pitch accents is given by the rule that the pitch accent at the right edge of the group is
obligatory, and non-final ones are optional. Second, when a non-final and a final accent occur on immediately adjacent syllables in the group, the non-final accent has to be removed. It is this Clash Resolution which we have shown to be defined by a domain that is also marked by phonological lengthening. Thus, we have independent evidence of the domain of application of the process. Moreover, this domain agrees well with the definition of the Phonological Phrase in the literature.

However, the optional application of Clash Resolution does not entirely agree with the proposed conditions on restructuring (i.e. the widening of the domain of application of the process). The assumption is that restructuring can take place if the lexical head of the first Phonological Phrase is immediately followed by a non-branching complement. Our duration measurements as well as the behaviour of Clash Resolution showed that this is not correct. Rather, Phonological Phrases are mapped onto the projections of X-bar category heads in the morpho-syntactic structure, where factors such as the number of syllables and speaking rate determine whether the Phonological Phrase spans an X' or an X" projection. Our acoustic measurements also showed that Clash Resolution is characterised by the deletion of the non-final pitch accent, while the simultaneous realisation of a pitch accent on an earlier syllable is optional.

Liaison could be shown not to be bounded by the Phonological Phrase. It does not agree with Clash Resolution, nor does it agree with the duration measurements. This means that the application of Liaison must be described in a different way. A provisional proposal, included at the end of the chapter, is that Liaison has a syntactically defined domain of application, and is to be accounted for with the help of a lexical insertion process that takes precompiled forms from the lexicon. Thus, we established the following points:

I. The application of Clash Resolution is conditioned by the Phonological Phrase.
II. The Phonological Phrase is measurable in the duration of the pre-boundary syllable.
III. Restructuring is not restricted to lexical heads and their non-branching complements. Rather, Phonological Phrases are mapped onto either X' or X" projections, depending on factors such as the number of syllables in the projection and speaking rate.
IV. Clash Resolution involves the deletion of a pitch accent, instead of a shift of the stress to an earlier syllable.
V. Pitch accent distribution is conditioned by the Phonological Phrase: phrase-final accents are obligatory, and clashes between immediately adjacent accents are prohibited.
VI. The application of Liaison is not conditioned by the Phonological Phrase.
VII. In general, the investigation provides a coherent phonetic and phonological picture of phrasing and pitch accent distribution.

8.2.3. The distribution of pitch accents: An OT account

In Chapter 4, the complex interaction between phrasing and pitch accent assignment
is formalised in an Optimality-Theoretic framework. The data of Chapter 3 are supplemented with data from the literature on the accentuation of non-final stressed syllables and function words in phrase-final position. The location of pitch accents is described by universal well-formedness constraints, which are ranked in a language-specific hierarchy in the grammar. The dominance relations between the constraints determine which form surfaces: all forms that violate higher-ranked constraints are rejected.

A constraint-based approach is argued to provide a more insightful account of phrasing and pitch accent assignment in French than a rule-based approach. In a rule-based approach, forms that appear to be the same at the surface level can only be accounted for if one assumes that they result from different grammatical processes (e.g. 'default' accenual patterns and patterns where a clash and/or restructuring is at play). Also, arbitrary stipulations of exceptions to the rules are required to account for prosodic variation. That is, rules that are obligatory in some contexts would have to be optional in others.

In the present proposal, all surface forms fall out from the same grammatical principles, formalised as a set of ranked constraints. Situations in which more than one surface form is acceptable are accounted for by allowing subsets of constraints to be unranked relative to each other, while still being crucially ranked relative to the other constraints in the grammar. In this way, the grammar predicts which forms surface in cases of prosodic variation, and still excludes categorically ungrammatical output forms. Thus, the constraint-based description gives a unified account of the French data.

8.2.4. Tonal variation: The data

Chapter 5 investigates the pitch movements that are realised in French Intonation Phrases in order to establish which differences contrast at the phonological level. In Intonation Phrase final position, we identify seven categories. The distinction between falling, rising, rising-falling, and falling movements from a penultimate unaccented peak is generally accepted in the literature. In addition, we assume a two-way distinction on the basis of the pitch level attained at the end of these pitch movements, with the exception of the rising-falling movement (i.e. the height of the rise and the depth of the fall are not distinctive). In Intonation Phrase internal position, we identify three categories: a rising, a rising-falling and a falling movement. The realisation of the distinct contours was found to vary with respect to (a) the onset (the stretch preceding the accented syllable), (b) the timing of the turning points (peak and dip) and (c) the range of the movement.

The analysis is primarily based on two speech corpora. The data had to meet two criteria: a sufficiently wide variety of intonation contours needed to be elicited for all phonological categories to be present, and the speech samples needed to be comparable across speakers and utterances, such that meaningful generalisations across individual realisations could be made. In order to meet the first requirement, two corpora were collected, the one containing read speech (an edited version of the
fairy tale *Cendrillon*), and the other spontaneous speech (a Map Task). The second requirement was met in part by using speakers with comparable backgrounds (four speakers for each corpus). For the intonation contours to be comparable across utterances, the elicitation of the intonation contours needed to be controlled. Although both elicitation methods allow for some degree of control, this is obviously easier to achieve in a reading task.

The data were analysed auditorily and acoustically, resulting in (a) an overview of the similarities and differences in the observed pitch movements in both corpora, and (b) a transcription of the pitch movements produced in the read speech data. These findings were compared with those of previous studies, and the phonological distinctions between the pitch movements were identified. Examples taken from the corpora illustrate the decisions taken in the course of the analysis, to make them transparent to the reader. Close copies of the original fundamental frequency traces are time-aligned with the phonetic transcription of the speech sample. Whenever this is appropriate, the realisations of all four speakers are presented, so that they can be compared.

8.2.5. Tonal variation: The analysis

Chapter 6 presents our proposal for an Autosegmental-Metrical account of French intonation. The following tonal primitives are specified at the phonological level of representation: (a) the pitch accents H* and H+H*, (b) the boundary specifications %L and %H (IP-initial) and L%, H% and 0% (IP-final), and (c) an L-tone, which is optionally inserted between two high starred tones. These elements combine into phonologically contrastive intonation contours when they are associated with the segmental structure. The grammar in (1) gives the tonal specification of an Intonation Phrase (curly brackets contain the set of tones available in the given position, parentheses indicate optional elements, and H*(L) can be repeated on any non-final stressed syllable).

\[
\begin{align*}
\{ & \%L \} \quad (H^* \ (L))_0 \\
\{ & \%H \} \quad H + H^* \\
\{ & L\% \} \\
\{ & H\% \} \\
\{ & 0% \}
\end{align*}
\]

The tonal string is interpreted in terms of fundamental frequency and time alignment of the phonetic targets. The targets of H* tones that immediately follow a high tone (including H+) are automatically downstepped, unless they are followed by a high boundary tone. Spreading accounts for phonetic variants in which pitch continues at the level of the preceding tonal specification.

It is argued that any alternative tonal representation that also complies with our assumptions should be rejected, as it either makes the wrong predictions, or involves cumbersome stipulations and unnecessary modifications of the phonological structure. At the end of the chapter, the analysis is compared with competing
Autosegmental-Metrical accounts. The discussion shows that in our proposal
I. a small set of tonal primitives accounts for the categorical distinctions;
II. only tones that have targets at the phonetic level are represented in the phonology;
III. there is no need to distinguish between an underlying and surface level in the phonology, since the tones of the underlying structure are not phonologically modified or deleted;
IV. the difference between word-initial and word-final pitch movements does not need to be accounted for in the tonal structure, but falls out from their position relative to prosodic constituent boundaries (higher constituent boundaries entail more pre-final lengthening);
V. the clear distinction between the phonological and the phonetic levels of representation makes explicit predictions about discreteness and gradience in variation in pitch, which can be experimentally verified.
In other words, the analysis is argued to be parsimonious, transparent and explicit.

8.2.6. Tonal variation: Categorical and gradient contrasts and listener judgements

The experimental investigation reported in Chapter 7 aims to resolve the controversy about the phonological categories that should be distinguished in French final rises, and to explore experimental techniques that can be applied to tackle such issues. More specifically, the questions were: (1) Is there a two-way distinction in final rises (H*H% versus H*0%), as is predicted by the account of Chapter 6?, and (2) Can differences in attitude or emotion be detected in phonetically different contours representing phonologically identical intonations? If phonetic variation is indeed found to be meaningful in French, this may explain why there is no consensus about the number and the nature of the contrasts in final rises.

A Categorical Perception experiment investigated the hypothesis that the contrast between H*0% and H*H% is primarily reflected in a difference in peak height, and that differences in timing and direction (level or rising in the final syllable) are gradient. Although the results of the identification task supported our hypothesis, the discrimination task did not corroborate this finding. Moreover, the predicted effects were absent in one of the control conditions. We have to conclude that the results are unreliable. Our interpretation is that phonological categories in intonation are not perceived categorically, and that therefore, the Categorical Perception paradigm may be unsuitable for the investigation of intonational contrasts.

A semantic task evaluated the influence of fundamental frequency variations on attitudinal meaning in two conditions: (1) the uncontroversial categorical contrast between final rises and rise-falls, and (2) the hypothesised gradient variation of the timing of the starting point (dip) of a final rise. We hypothesised a strong effect for sûr 'certain' in the first condition, since rises can signal continuations or questions, and the rise-falls assertions. Etonné 'surprised' was expected to show the reverse,
but much weaker effect. Overall weaker results were predicted for the second condition, as it was assumed to be gradient. The results of the contrastive judgements confirmed our hypothesis about the categorical condition. In the second condition, a late rise was found to sound less surprised and more certain than an early rise, but the effects were much weaker than those measured in the categorical condition. This finding suggests that dip timing in final rises can be used to signal different degrees of assertiveness, and therefore is meaningful. Nevertheless, since the effects for ‘certain’ in particular were rather weak, timing is unlikely to be a sufficient cue for the grammatical function of the rise.

We conclude that, despite the disappointing result of the Categorical Perception experiment, our hypothesis of a distinction in final rises based on peak height is likely to be correct. The effects observed in the semantic task can easily be accommodated in a phonological model in which a phonetic level of representation, where gradient variation can convey subtle meaning differences, is distinguished from a phonological level, where variation functions contrastively.

**8.3. Scope of the study**

The findings in this study have theoretical and methodological implications for the investigation of intonation. Apart from the relevance of the findings, the following subsections will discuss the limitations of the study and suggest some topics for further research.

**8.3.1. Phonological theory**

The Optimality framework was shown to permit an integrated account of all French accentual patterns if partial ranking is adopted to describe prosodic variation. Since the surfacing of several optimal output forms is covered by one single grammar instead of two or more competing grammars, as has been proposed elsewhere, the occurrence of variation within a language is theoretically restricted, and is formally distinguished from variation between languages.

This approach has interesting implications for prosodic variation across languages. Partial ranking can be said to reflect the expected sensitivity of postlexical processes to factors such as boundary weight, rate of speech, and speaking style, which lead to variation in phrasing and accentuation. Although the constraints involved in French phrasing and accentuation may be different in other intonation languages, similar processes arise there. Since the rankings are language-specific, but the constraints themselves are universal, we would expect that the same (or at least closely related) constraints are involved in these processes.

It remains to be explored how sociolinguistic factors, speaking style and rate of speech interact to determine the speaker’s choice for a pitch pattern. Only when we know which variants surface in a particular context, the explanatory value of partial ranking can be evaluated, as is the case for any model of language variation.
The tonal investigation confirms that intonation research will benefit from an Autosegmental-Metrical approach in which the phonological and phonetic levels of representation are clearly separated. The approach forces the investigator to make clear decisions about the grammatical status of an intonational phenomenon; since observed variation has to be described as either a difference in the tonal structure, or as a difference in phonetic realisation, the choice needs to be motivated, and the description is verifiable. In addition, clear hypotheses can be formulated about the contribution of variations in pitch to the interpretation of intonation contours.

However, as long as it is unclear how factors such as the proximity of pitch accents and prosodic boundaries, topic structure, and the nature of segments affect the realisation of the tones, the phonetic implementation rules must remain rather vague, and the validity of the phonetic part of the description is limited. The present study does not address this issue. Although a clear hypothesis was developed about, for instance, the grammatical status of dip timing in final rises (not phonological), we cannot describe the alignment of the low target with the segmental structure. Further research on the fundamental frequency values and the timing of the targets is needed for the description to be directly applicable in, for instance, speech synthesis, language learning and forensic research.

8.3.2. Methodology

Unlike previous analyses of French intonation, the present description is based on a variety of experimental methods: production and perception experiments, and a corpus study. In general, this approach has the advantage that intuitions, which are often unreliable when prosodic phenomena are concerned, are not the only basis of the analysis.

A carefully controlled production experiment investigated the domain of application of Liaison and Clash Resolution. To our knowledge, no experimental evidence has been presented so far against the claim that Liaison is bounded by the Phonological Phrase, although a number of corpus studies have revealed similar findings in the past. By combining the evidence from acoustic analyses with that provided by expert judgements, the conditions on the application of Clash Resolution and the phonological nature of the rule could be established.

The tonal analysis was based on a corpus of directly comparable speech samples in two speaking styles. The data from the fairy tale corpus in particular were argued to provide a good starting point for the generation of hypotheses about phonological distinctions in the pitch movements, because the elicitation of the intonation contours can be constrained, and Intonation Phrase boundaries are usually easy to detect. The main function of the spontaneous speech corpus was to provide a larger variety of speech samples.

Some of the more controversial predictions of the tonal analysis were tested in two perception experiments. The perception experiments could also be seen as a first step towards exploring ways to investigate the relation between intonational meaning and the phonetic and phonological structure of intonation. Although this topic falls
outside the scope of this study, it would be interesting to establish how successful the analysis is in capturing similarities in meaning as similarities in form, as this would allow us to assess how well the analysis explains the data.

However, the methodology also imposes a number of limitations on the study. First, only relatively small bodies of data can be analysed, because the method is very time-consuming. As a consequence, a number of issues could not be dealt with, such as focus, emphasis and deaccentuation. Also, we have been unable to verify all of the predictions of the tonal analysis. For instance, all Intonation Phrase final rising-falling movements are analysed as $H^*L\%$, regardless of the pitch level reached at the end of the fall. An imitation task might be useful in determining whether variation in the height of the final target is indeed gradient.

Second, the validity of our findings is limited by the conditions of our experiments. Our hypotheses could only be evaluated if the experiments were carefully controlled. However, this potentially limits the extent to which the results can be generalised. For instance, the analysis of Chapter 5 describes observed differences in speech samples produced by particular speakers in a specific context, and artificially manipulated speech was used in the experiments of Chapter 7. Thus, although the findings reported in this study can be generalised to a group of speakers, it is unclear whether other groups of speakers would give the same results. Also, all experimental data were produced in laboratory circumstances, and the corpus study was limited to two speaking styles, which raises the question whether the findings generalise to speech produced in different speaking styles under normal circumstances. Nevertheless, since the speakers’ (and listeners’) phonological system can be assumed to be independent of experimental circumstances, useful inferences can be drawn about phonological structures in intonation.
References

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REFERENCES


REFERENCES

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REFERENCES


Appendix A

Materials and instructions for the production experiment testing the application of Liaison and Clash Resolution (Chapter 3)

1. Materials used in the experiment, with test items printed in italics

Condition 1
1. Les petites filles de mon voisin se donnent _de jolis airs_ lorsqu’elles me rendent visite.
2. Nous avons dû fermer notre restaurant après une intoxication alimentaire causée par une omelette norvégienne faite d’œufs contaminés. Je te dis que _ces damnés œufs_ vont provoquer notre ruine.
3. Le groupe d’étudiants dans mon cours de droit européen est très hétérogène; ils sont _de divers âges_ et ils n’ont pas du tout le même niveau.
4. Comme je me suis morfondu au mariage de notre cousin! Je dois avouer que j’ai vraiment apprécié toutes ces jolies tantes et _ces charmants oncles_ qui criaient que j’avais tellement grandi.
5. Dans cette cave, on a trouvé _d’anciens os_ d’un tyrannosaure.
6. A mon avis, Charles se fout complètement de sa femme, ce dont témoignent _les méchants actes_ qu’il commet souvent envers elle.
7. Ça fait presque trente ans que _les premiers hommes_ ont mis le pied sur la surface lunaire.
8. Le théâtre prévoit un grand succès. Pourtant, les acteurs doivent encore bien répéter _les derniers actes_ de la pièce avant la première.
9. Le général donnait toujours _de mauvais ordres_ auxquels on n’arrivait jamais à obéir.

Condition 2
1. Après l’incendie au bureau de poste, on a retrouvé _des colis ocre de fumée_ qui n’avaient pas brûlé.
3. Lors de ma visite en Australie, je me suis rendu compte qu’il y a _des hivers autres qu’en Afrique du Sud._
4. La qualité de ce château dépend _des sarments aptes à produire_ de grands crus.
5. En Afrique, on considère encore _les anciens aptes à gérer_ les affaires du village.
6. Après cinq ans de combats féroces, les rebelles ont fait un coup d’état très sanglant. Le lendemain les méchants ivres de succès infestaient la ville.

7. Dans les années cinquante, les calculs de plus en plus longs et compliqués forçaient le développement rapide de l’ordinateur. Ils étaient les premiers aptes à faire de tels calculs.

8. En jouant au loto, une famille de dix personnes vient de gagner le gros lot. À la télévision on a vu ces derniers ivres de bonheur partir en vacances ensemble.

9. Le maire vient de prendre plusieurs mesures visant à remédier à la détérioration des banlieues. Il faut l’avouer, ce sont des projets aptes à résoudre les problèmes.

Condition 3

2. Il avait vécu des années après pendant la guerre.

3. Depuis deux ans nous avons des hivers après en Europe.

4. La sécheresse de l’été dernier a tout à fait ruiné le vigneron: il y a des sarments ocre à perte de vue.

5. Beaucoup pensent que seuls les jeunes sont capables d’accomplir de grandes choses. Moi, je pense que les anciens aptes existent toujours.

6. Déjà tôt dans la soirée il y avait un groupe d’ivrognes très embêtants au café. Le patron a fini par jeter les méchants ivres dehors.

7. J’adore l’ocre pour les chambres à coucher, mais le stock de draps jaunes était épuisé. Le marchand nous a promis de mettre de côté les premiers ocre qu’il reçoit.


9. Marcel veut aller prendre des photos d’art dans les forêts ocre cet automne.

Control Condition
1. Elle avait mis sa plus jolie jupe pour faire bonne impression.

2. Après sa retraite il a passé encore de belles années calmes dans sa maison de campagne.

3. Comme le texte contient de trop divers styles il est improbable qu’il soit écrit par une seule personne.

4. Mes hôtes ont faits des efforts pour me plaire. A l’aéroport leur très charmant fils venait me chercher.

5. Nous nous connaissons depuis longtemps; il y a de très anciens liens entre nos familles.

6. Claude trouve que Fifi est un trop méchant chien à son goût.

7. Après de longues discussions, le jury a enfin décidé quel film nominé serait leur tout premier choix.

8. Mon coureur favori était le tout dernier homme à franchir la ligne d’arrivée.

9. Il paraît que sa maladie n’est pas un trop mauvais cas de cancer.
2. **Instructions for the subjects**

Lors de cette expérience, vous devrez lire une soixantaine de phrases. Ces phrases ont été imprimées sans ponctuation. Lisez chaque phrase mentalement avant de la prononcer à haute voix. Prenez votre temps et parlez aussi clairement que possible. Essayez de ne pas faire de bruits parasites (par exemple: en tournant les pages ou avec votre crayon, etc.) Si, toutefois, vous hésitez ou toussez en prononçant une phrase, ce n’est pas grave; vous n’avez qu’à la répéter. Merci et bon courage.

3. **Instructions for the judges**

L’expérience que j’ai faite visait - entre autres - à définir les cas où des locuteurs natifs du français appliquent ce que j’appelle ici une ‘Rétraction d’Accent’ (RA). Par exemple:

```
le dernier an  ->  le dernier an
*   *            *< . *
```

Evidemment, ce processus pourrait aussi être conçu comme l’effacement de l’accent final accompagné d’un placement d’un accent initial à l’intérieur du même mot. Cette question théorique ne touche d’ailleurs pas à l’expérience même, qui recherche les conditions dans lesquelles se produit le phénomène.


Vous entendrez chaque enregistrement d’une phrase-cible deux fois de suite avec un intervalle de 5 secondes entre les phrases-cibles. Après chaque locuteur il y aura une pause suivie d’un son. Evidemment, vous pouvez arrêter et rebobiner la cassette à n’importe quel moment. Merci et bon courage.

**Instructions for condition 2**

Dans cette partie vous entendrez 10 extraits par locuteur. Pour chaque extrait, vous devrez indiquer

1. où le locuteur fait un découpage prosodique
2. où se trouve l’accent/les accents

Vous pouvez faire les deux types de jugement en même temps, ou, si vous le préférez, vous rebobinez après la première écoute.

1. Découpage prosodique

Le locuteur rendra la coupure entre deux mots de façon plus ou moins évidente. Vous devrez indiquer où se trouve la coupure la plus importante. Par exemple:
1. les *anciens* aptes à gérer ou bien: 1. les *anciens* | aptes à gérer

Si vous pensez que le locuteur ne produit pas de coupure à l’intérieur de la phrase-cible, ne notez rien.

Si vous êtes sûr de votre évaluation, vous laisserez de côté les cases ‘certitude coupure prosodique’: vous n’y notez rien. Sinon, vous avez la possibilité d’indiquer la certitude de votre jugement sur une échelle de 1 à 5. Dans l’exemple suivant, vous auriez indiqué que vous n’êtes pas du tout sûr que la coupure se trouve entre *anciens* et *aptes*:

<table>
<thead>
<tr>
<th>Certitude coupure prosodique</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. les <em>anciens</em></td>
<td>aptes à gérer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Accentuation
Dans chaque phrase-cible j’ai souligné un mot pour lequel vous devrez indiquer quelle syllabe est la plus proéminente, c.-à-d. la syllabe la plus accentuée. Vous marquerez la syllabe qui vous semble la plus proéminente d’une croix. Dans l’exemple suivant, la première syllabe de *anciens* est la plus proéminente. Vous marquerez d’une croix de la façon suivante:

<table>
<thead>
<tr>
<th>Certitude coupure prosodique</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accent</td>
<td>Initial</td>
<td>Final</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. les <em>anciens</em></td>
<td>aptes à gérer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comme vous le savez sans doute, une telle proéminence peut se réaliser - entre autres - sous forme d’un allongement et d’une fréquence fondamentale plus élevée. Vous devrez tenir compte de tous ces facteurs, ce qui implique qu’il peut y avoir des cas où, par exemple, la syllabe initiale porte un ton haut, tandis que la syllabe finale est allongée. Si, par conséquent, vous ne pouvez pas choisir entre les deux, vous marquerez les deux cases d’une croix.

**Instructions for conditions 1 and 3**
Dans cette partie vous entendrez 32 phrases-cibles par locuteur. Comme avant, vous marquerez la syllabe du mot souligné qui vous semble la plus proéminente d’une croix. Dans l’exemple suivant, la dernière syllabe de *surface* est la plus proéminente. Vous marquerez d’une croix de la façon suivante:

<table>
<thead>
<tr>
<th>Initial</th>
<th>Final</th>
<th>?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. la <em>surface</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Et encore, si vous ne pouvez pas choisir entre les syllabes, vous marquerez les deux
cases d’une croix. Vous avez la possibilité marquer la case ‘?’ si vous vous doutez fortement de votre jugement.

4. Judgements of the prosodic boundaries realised in Condition 2, classified by item

“W₁” represents the noun in each sequence, “W₂” the following adjective or adverb, “W₃” the third lexical word (here a noun or verb); “?” stands for cases in which the three judges disagreed.

<table>
<thead>
<tr>
<th>Items:</th>
<th>W₁</th>
<th>W₂</th>
<th>W₃</th>
<th>W₁</th>
<th>W₂</th>
<th>W₃</th>
<th>?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. des colis ocre de fumée</td>
<td>14</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. ces damnés ivres de vodka</td>
<td>13</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. des hivers autres qu’en Afrique</td>
<td>16</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. des sarments aptes à produire</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. les anciens aptes à gérer</td>
<td>12</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. les méchants ivres de succès</td>
<td>9</td>
<td>0</td>
<td>8</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. les premiers aptes à faire</td>
<td>6</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. ces derniers ivres de bonheur</td>
<td>16</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. des projets aptes à résoudre</td>
<td>7</td>
<td>9</td>
<td>0</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>40</td>
<td>16</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. The number of applications of Liaison and Clash Resolution in Condition 3.

For Clash Resolution, “=” indicates equal prominence judgements and “?” indicates disagreement cases.

<table>
<thead>
<tr>
<th>Items</th>
<th>Liaison</th>
<th>Clash Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>no</td>
</tr>
<tr>
<td>folies ivres</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>années après</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>hivers après</td>
<td>0</td>
<td>18</td>
</tr>
<tr>
<td>sarments ocre</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>anciens aptes</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>méchants ivres</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>premiers ocre</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>derniers aptes</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>forêts ocre</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>137</td>
</tr>
</tbody>
</table>
Appendix B

Materials and instructions used for the construction of the speech corpora, and details about the prosodic structures produced in the read speech corpus (Chapter 5)

1. Instructions Cendrillon as line drawings

L'objectif de cette expérience est de vous faire raconter l'histoire de Cendrillon telle que vous vous en souvenez. Pour vous aider, vous aurez à votre disposition une série d'images qui retrace les événements principaux du conte. Ces images sont numérotées dans leur ordre chronologique (1 à 10). Prenez votre temps et parlez aussi clairement que possible.

2. Instructions read speech corpus (Cendrillon)

Lors de cette expérience, vous devrez lire le texte du conte imprimé sur la page suivante. Imaginez-vous que vous vous adressez à un petit enfant qui ne connaît pas l'histoire. Lisez le texte mentalement avant de le prononcer à haute voix. Prenez votre temps et parlez aussi clairement que possible. Essayez de ne pas produire de bruits parasites (par exemple: en tournant les pages ou avec votre crayon, etc.) Si, toutefois, vous hésitez ou toussez en prononçant une phrase, ce n'est pas grave; vous n'avez qu'à la répéter. Merci et bon courage.

3. Materials read speech corpus: fairy tale Cendrillon

Il était une fois une gentille jeune fille dénommée Cendrillon. Son père s'était remarié avec une vilaine femme, qui avait deux filles. La belle-mère en question, qui aimait mieux ses filles, lui faisait faire le ménage. Toute la journée, elle devait faire la cuisine, nettoyer la maison, laver le linge et faire la vaisselle. Ses demi-sœurs, Javelle et Javotte, lui commandaient de ranger leurs affaires, alors qu'elles passaient leur temps à se faire jolies devant le miroir. Mais malgré sa vie malheureuse, Cendrillon vivait en harmonie avec les animaux dont elle s'occupait.

Voilà qu'un jour, le roi annonce qu'il va donner un bal auquel il invite toutes les jeunes filles du royaume. Mais la marâtre de Cendrillon ne veut pas qu'elle y aille:
“Non! Tu n’iras pas! Tu n’es pas faite pour ce monde-là!” D’un air dédaigneux, Javelle ajoute que de toute façon, jamais personne ne voudrait danser avec elle parce qu’elle manque d’élégance.

Une fois seule, Cendrillon se met à pleurer à chaudes larmes. Sa marraine, une gentille fée, arrive alors dans un nuage rose, et lui demande “Ma chère petite fille, pourquoi pleures-tu?” Cendrillon lui avoue tous ses malheurs. “Mais n’aie pas de chagrin”, dit la marraine “Tu sais que je peux tout arranger, n’est-ce pas? Tu iras au bal comme tes sœurs.” D’un coup de baguette magique, elle métamorphose Cendrillon en une ravissante princesse. La voilà dans une robe, une magnifique robe de soie rose, avec de jolis gants de dentelle et des chaussures de verre. “Néanmoins, il y a une condition,” lui dit la bonne fée, “Il faut que tu reviennes avant minuit.”

Arrivée au château, Cendrillon n’arrive pas à détacher les yeux des splendeurs qui l’entourent. Le prince aperçoit Cendrillon du haut des marches. Comme elle est la plus belle de la soirée, il s’avance vers elle et lui demande “Mademoiselle, voulez-vous danser cette valse avec moi?” Cendrillon, heureuse, accepte. Toute la soirée, ils dansent, ils virevoltent au milieu de la salle. Le prince, ébloui par sa beauté, n’a d’yeux que pour elle. Mais soudainement, les douze coups de minuit sonnent. Cendrillon se rappelle les mots de sa marraine, et s’enfuit en courant. Dans l’escalier, elle perd une pantoufle de verre. Le prince qui la poursuit trouve la pantoufle. Malheureux, il l’appelle de loin: “Ma mignonne! Ne partez pas, je vous en prie!” Hélas! Cendrillon a déjà disparu.

Dès le lendemain, le prince parcourt tout le royaume pour trouver la jeune fille à qui appartient la pantoufle de verre. Quand il arrive à la maison de Cendrillon, la belle-mère veut que ce soient ses deux filles qui essayaient la pantoufle. Mais la pantoufle est trop petite. Le prince qui aperçoit Cendrillon dans un coin lui demande “Approchez, Mademoiselle, approchez. Venez essayer cette pantoufle de verre.” Cendrillon s’approche et met le pied dans la chaussure, qui lui va à merveille. Ravi d’avoir retrouvé sa bien-aimée, le prince la prend dans ses bras et l’emmène dans son château.

Ils se marièrent, furent heureux, et ils eurent beaucoup d’enfants.

### 4. Prosodic structures produced in the read speech corpus

The four speakers produced a total of 386 Intonation Phrases in 176 utterances. An IP contained on average 2.82 final word-pitch accents (936 in all) and 0.4 word-initial pitch accents (154 in all), and the average distance between the pitch accents was 1.74 syllables. The figures given below show all observations added over the four speakers, and the counts should be considered as estimates, because it was not always entirely clear whether a pitch accent had actually been realised.

In the first figure, Intonation Phrases are plotted against word-initial (dotted line) and word-final pitch accents (solid line; pitch accents on monosyllabic words are counted as word-final accents). Most Intonation Phrases were realised with one or two word-final pitch accents. One Intonation Phrase was realised with seven word-final pitch accents, and two had nine, but there were no Intonation Phrases with eight word-final
pitch accents, and Intonation Phrases with more than nine did not occur. Function words were realised with a word-final accent in 21 cases (14 auxiliary verbs, 4 determiners and 3 prepositions). In 81 cases, a lexical word did not have a word-final pitch accent, but in all of these cases, the X' category word was dominated by an X" word (mostly a verb followed by a direct object, e.g. nettoyer la maison). Only 154 out of the 386 Intonation Phrases were realised with a word-initial pitch accent. There was usually only one of them, and more than four word-initial pitch accents never occurred within one Intonation Phrase. In two cases, the movement was aligned with the second syllable of the word (in métamorphose and mademoiselle).

In the second figure, the number of pitch accents is plotted against the number of syllables that intervened between them (the numbers are based on the subjects' actual pronunciations of the text, i.e. word-final schwa’s are counted as a syllable when they are produced). In 80 cases, the pitch accents were immediately adjacent (24 occurred within the IP, and 56 straddled an IP boundary). The majority of the pitch accents were one or two syllables apart, and at most, six syllables intervened between them.
5. List of landmarks used in the maps of the Map Task (asterisks indicate landmarks that are not identical in the two versions of the map)

Map 1
1. des maisons obscures
2. un château du Moyen Age*
3. un grand abribus
4. un verger vert*
5. des granges effondrées
6. un petit pin*
7. une colline*
8. la grande plaine/des vastes prairies*
9. l'orfèvre
10. le tonnelier*
11. une église romanesque
12. un vignoble*
13. Le Profond Etang
14. Le Bel Etang

Map 2
1. une station balnéaire*
2. un nouveau phare
3. des dunes*
4. des forêts immenses
5. un ancien abri antatomique*
6. des torrents effroyables
7. des champs inondés
8. deux fermes abandonnées*
9. un désert sec*
10. un hameau/une bourgade rurale*
11. un bon épicier
12. un ancien hôtel*
13. L'Océan Gris
14. L'Océan Vert
6. Reduced copies of the maps (only the versions with the routes are given).

Map 1
une bourgade rurale

un bon épicier

un ancien hôtel

une station balnéaire

des torrents effroyables

des champs inondées

un ancien abri antiatomique

un nouveau phare

L'Océan Vert

L'Océan Gris

Début

une station balnéaire

two abandoned farms

une station balnéaire

Appendix C

Orthographic transcription of the Map Task tapes (Chapter 5)

Whispered or murmured passages are given between brackets; whenever speech from two speakers is transcribed on the same line, the words spoken by the second speaker were pronounced during the last part of the first speaker’s utterance.

Isabelle (Instruction Giver) and Karine (Instruction Follower):

K: eh... Est-ce que tu pourrais m’indiquer le chemin pour aller au Bel Etang?
I: Au Bel Etang... Eh... oui. Donc eh... tu vois les maisons obscures?
K: Oui.
I: Donc, eh, tu continues tout droit, avec les maisons obscures à ta droite.
K: Oui.
I: Ensuite, tu vas arriver vers le Profond Etang.
K: Oui.
I: Tu vois? Donc là, tu traces une courbe pour aller, il y a un petit pin tout à droite de la feuille - je ne sais pas si tu le vois -
K: Oui.
I: Donc, tu fais comme si tu allais là, mais tu t’arrêtes à mi-chemin entre le Profond Etang et le petit pin.
K: Oui.
I: Là, tu vois un grand abribus?
K: Oui.
I: Oui. Alors là, tu fais un virage sur toi-même pour passer sur l’arrière de l’abribus, enfin, pas le contourner si tu veux, tu passes derrière
K: Derrière l’abribus? I: C’est clair?
I: Ben, ce qu’on voit de, ce qu’on voit c’est l’avant donc eh
K: Oui.
I: tu passes sur l’arrière.
K: Ah, d’accord.
I: Donc, ça te fait comme un virage, une boucle.
K: Ah, d’accord.
I: Eh? Tu... tournes autour de l’abribus. Un tout petit peu.
K: Oui.
I: C'est bon jusqu'à maintenant?
K: Jusqu'à maintenant, eh... oui, je crois que ça va.
I: eh Est-ce que devant toi tu vois un verger vert?
K: Non, non. Je vois pas de verger vert.
I: Et, est-ce que, un peu plus loin devant toi, tu vois des granges effondrées?
K: Oui
I: Voilà.
K: Eh A côté du petit pin?
I: Oui, il y a un autre petit pin, mais ce n'est pas celui de tout à l'heure.
K: Ah bon parce que moi, l'autre, alors, je l'avais pas.
I: Ah K: Mais bon I: alors, on recommence. Eh, le premier petit pin, il est plus haut que les granges effondrées
K: Oui.
I: au même endroit, entre les maisons obscures et le grand abribus. Situe en hauteur, si tu veux.
K: Donc, tout à fait sur la gauche I: Toi,
I: tout à droite.
K: sur la droite I: sur la
I: droite. Sur la même ligne que les granges effondrées, mais tu t'arrêtes eh, au niveau entre maisons obscures et grand abribus.
K: Bon, d'accord. Donc, ça s'appelle aussi un I: un petit pin.
I: Oui.
K: D'accord.
I: D'accord? Donc eh tu repars devant les maisons obscures, tu fais une petite boucle,
K: Devant les maisons obscures?
I: Ben. Enfin, tu passes devant les maisons obscures, tu vas jusqu'au milieu de la feuille, et là, tu fais une boucle qui passe derrière l'abribus
K: Et l'abribus, c'est le grand abribus?
I: Oui, un grand abribus.
K: Et, est-ce que t'as un château du moyen âge?
I: Non.
K: Entre eh, les maisons obscures et l'abribus.
I: Non, pas du tout.
K: T'as rien du tout?
I: Non, rien du tout.
K: Donc, je passe devant les maisons obscures,
I: Oui
K: Je descends, enfin, comme si je descendais I: Tu descends,
I: tu passes tu vas comme si tu allais vers le petit pin, tu tournes, tu fais une boucle,
K: Oui
I: tu vas enfin comme si tu allais vers le petit pin au milieu de ta feuille et tu fais demi-tour.
K: D'accord.
I: D’accord?
K: Mmm.
I: Tu passes derrière l’abribus, donc,
K: Je passe derrière l’abribus
I: Est-ce que tu as tu as le Profond Etang?
I: Oui, tout à gauche. Et tu as la grande plaine?
K: Non
I: Non. Bon, c’est pas grave.
K: Pas la grande plaine.
I: Alors, tu tournes un petit peu autour de l’abribus,
K: Oui
I: Sur la gauche de l’abribus? Hein? Ss
K: Oui
I: Et puis tu vas jusqu’aux granges effondrées, mais pas, tu fais pas un chemin droit, tu le fais un petit peu tortueux, jusqu’en-dessous des granges effondrées. Entre les granges effondrées et le petit pin. Enfin, le deuxième petit pin.
K: Oui, d’accord.
I: Voilà. Tu fais une boucle autour du deuxième petit pin – c’est-à-dire, que tu passes par derrière et que tu reviens devant
K: mm
I: Est-ce que tu as une colline?
I: Ah, alors ça, les vastes prairies, c’est la grande plaine. Pour moi.
K: (D’accord)
I: Est-ce que plus bas que le petit pin, enfin, plus bas que la grande plaine et les vastes prairies, t’as un orfèvre?
K: Oui.
I: Oui. Alors, eh, sur la diagonale entre l’orfèvre et le petit pin,
K: Oui.
I: un peu plus proche du petit pin que de l’orfèvre,
K: Oui.
I: tu as une colline, donc, tu dessines un petit eh, une petite montagne, mais pas très haute, hein?
K: Et eh c’est eh plus près du petit pin donc eh I: Oui
I: plus près et plus eh assez ... C’est à deux centimètres en-dessous du petit pin, et deux centimètres à gauche du petit pin, quoi.
K: D’accord
I: D’accord?
K: Donc, une petite colline.
I: Voilà. Donc, ton chemin passe […] devant le petit pin
K: Oui
I: (enfin, tu passes de derrière à devant,) au-dessus de la colline,
K: ( ? j’étais un peu trop loin) Devant le petit pin. Au-dessus de la colline
K:   C’est eh tout droit ou I: Eh oui,
I:   pratiquement tout droit.
K:   Donc, jusqu’à gauche. Donc, en fait je contournes l’orf I: Tu con-
I:   tournes la maison, oui. Ensuite eh, est-ce que tu as une église romanesque?
K:   Oui, j’ai aussi le tonnelier. Entre eh l’orfèvre et une e et l’église.
I:   Donc, moi j’ai pas de tonnelier mais j’ai le vignoble. Eh, ton tonnelier, il est en diagonal entre l’orfèvre et l’église?
K:   Eh, pas vraiment, il est à la gauche de l’église I: Oui K: Il est assez proche, mais eh [...] en dessous de l’orfèvre, quoi
I:   (en dessous de l’orfèvre) Donc, tu passes derrière l’orfèvre, [...] tu passes au-
dessus du tonnelier, [...] et tu descends entre le tonnelier et l’église, [...] 
K:   D’accord.I: et tu passes devant l’église, enfin en dessous de l’église romanesque, et là, ton étang, il fait comme une pièce de puzzle,
K:   Oui.
I:   avec un creux rentré. Enfin, un creux quoi K: Oui,
K:   vers le bas à droite, quoi. I: oui, vers
I:   le bas à droite. Et le but est dans ce creux, donc tu passes devant l’église et tu descends un tout petit peu, et tu te trouves au but.
K:   A peu près au milieu du creux?
I:   Au milieu du creux, oui.
K:   D’accord.
(K: donc le but est ici. I: J’espère que ça va. K: Voilà)

Karine (Instruction Giver) and Isabelle (Instruction Follower):

I:   Eh, oui, bonjour, excuse-moi. Est-ce que tu pourrais m’indiquer quel chemin pour aller au but, s’il te plaît.
K:   Oui, alors ehm, donc, tu... pars eh à côté de la station balnéaire?
I:   Oui.
K:   Oui.
I:   A gauche de la station?
K:   A gauche de la station, oui. Eh, c’est là ou il y a le début, c’est ça?
I:   Oui.
K:   Donc, tu passes à côté de la station, eh toujours à gauche,
I:   Oui.
K:   pas eh vraiment droit, mais un petit peu eh [...] 
I:   Oui
K:   un petit peu en arrondi sur la gauche,
I:   En arrondi qui tourne à gauche?
K: Non non, tu tournes pas à gauche, tu continues toujours comme si tu allais tout
droit, mais ça fait un petit virage, quoi.

I: D'accord.
K: Et après la station balnéaire, il y a eh un nouveau phare.
I: Oui, et, est-ce que tu as des dunes à côté du nouveau phare?
K: Non I: Non K: il y a eh l'Océan Gris.
I: Non, mais les dunes sont de l'autre côté.
K: De l'autre côté, non. Il n'y a pas de ... Par contre, il y a un ancien abri antiatomique.
I: Ah, non je ne le vois pas. K: t'as pas de
K: Alors c'est, par rapport au nouveau phare, [...] un petit peu au-dessus. En face, je sais pas, à la droite de de l'abri antiatomique,
I: Oui.
K: il y a les forets immenses.
I: D'accord. Alors, par rapport au phare et à l'abri, je vais...
K: Donc, tu Donc, après avoir passe devant la station balnéaire, tu continues, tu passes aussi devant le phare, à la gauche du phare,
I: Très loin, ou?
K: Non non, juste juste à côté, à un demi centimètre, ou... Vraiment très près du phare.
I: Oui.
K: Après ça [...] ça va, la route va un petit peu sur la droite, mais légèrement, c'est pareil, c'est un un petit virage, quoi, très léger.
I: Oui.
K: Et donc après, ça retourne un peu, ça cou ça eh T'as les forets immenses sur ta droite, donc tu, [...] et à gauche il y a l'ancien abri antiatomique.
I: Oui.
K: Donc, tu passes entre les deux, mais tu passes plus près des forets immenses que [...] de l'ancien abri antiatomique.
I: Oui.
K: Donc I: j'atteste
I: donc, au-dessus des forets immenses
K: Ouais, tu vas pas sur la droite, hein?
I: Non.
K: Tu continues toujours eh à peu près tout droit, quoi.
I: Oui.
K: Et, tu vas arriver un petit peu plus haut, il y à a droite, les torrents effroyables,
I: Oui, c'est ça.
K: et à gauche des champs inondés.
I: Oui.
K: Et eh, oui ça fait une ligne un petit peu au milieu. Enfin, ça se rejoint I: Oui, les torrents,
I: oui, eh, oui.
K: Donc eh, tu continues, ça fait [...] Une fois que t'as passe les forets immenses, ça fait, c'est pareil, ça fait un petit peu sur la droite en... Enfin, ça tourne un petit
peu, quoi. Et toujours en allant à peu près tout droit. Jusqu'à eh les torrents qui rejoignent les champs inondés.
I: Et là, je passe par-dessus les torrents?
K: Tu passes, oui, tu [...] Ton chemin passe sous les torrents
I: Oui.
K: Il se rapproche un peu des champs inondes, donc un petit peu sur la gauche.
I: Oui.
K: Donc, le chemin passe très près des champs inondes.
I: Oui. Est-ce que tu as un désert sec?
K: Non.
I: Qui se trouve[...] entre les champs inondes et les torrents effroyables, mais un peu plus au-dessus.
K: Sur la droite ou sur la gauche? I: Eh
I: entre les deux, carrément dans le creux. Tu sais, il y a une bosse à un moment?
K: ouais I: Enfin, dans le dessein, et les torrents, ça fait des pics
K: Ouais
I: Ben, il se trouve carrément un creux, il se trouve, à ce niveau-là un tout petit peu plus haut, cinq centimètres au-dessus
K: Hm d'accord. Est-ce que t'as sur la gauche en-dessus des champs inondes deux fermes abandonnées?
I: Non.
K: Non. Alors, elles sont juste au-dessus des champs inondes,
I: Oui
K: Enfin, à peu près, je sais pas eh
I: Au-dessus de l'arrondi qui fait colline? Ou un petit peu plus à gauche. K: un petit peu
K: plus à gauche. Pas beaucoup, I: oui, K: mais, vraiment, juste eh Il y a l'arrondi de la colline, et eh enfin, ehm
I: Et la fin du champ
K: Du champ. Et eh la première ferme est eh vraiment juste après l'arrondi, quoi.
I: D'accord.
K: Donc, le chemin, quand t'as passe eh donc t'es passe sur les torrents, eh, donc tu passes à côté des champs inondes,
I: En direction des fermes?
K: En direction des fermes, c'est pareil, le chemin continue, a, ehm, à peut-être un demi centimètre à droite des fermes, quoi. I: Oui K: Tu passes, et là, tu vas toujours tout droit en haut, à gauche, I: Oui, K: Là, t'as une bourgade rurale
I: Eh, non, moi, j'ai un hameau. C'est la même chose, ( je sais pas,)
K: C'est eh, trois petites maisons?
I: Oui.
K: Et eh
I: Et est-ce que tu as un bon épicier à côté?
K: Oui, au-dessus des enfin, à droite, un petit peu.
I: Oui, à droite. Un petit peu au-dessus, oui.
K: Un petit peu au-dessus, ouais. Donc, tu passes devant le eh, les trois petites maisons,
I: Alors, je fais un...
K: Une fois que t’as passe les fermes abandonnées ça va I: Oui, je Monte tout droit.
K: Tout droit, oui.
K: Ouais
I: Oui Et eh K: Et I: je passe entre eux ou pas?
K: Tu passes, ouais, entre […] les petites maisons et l’épicier.
I: Bon, d’accord. Donc là, je suis tout en haut de ma feuille.
K: Oui, alors, tu vas pas tout en haut tout en haut, […] Enfin, si, parce que tu contournes le l’épicier
K: Tu passes au-dessus, tu vas sur la droite I: Sur la droite,
I: Oui.
K: Après, plus bas, eh à peu près au milieu de la feuille sur vers la droite, il y a un ancien hôtel
I: Eh non, je n’ai pas l’ancien hôtel.
K: T’as pas l’ancien hôtel?
I: Est-ce qu’il est plus haut que les torrents effroyables?
I: Et, est-ce que tu as l’Océan Vert?
K: L’Océan Vert, oui, tout à fait à droite.
I: Et alors l’hôtel, par rapport aux torrents et l’océan,
K: Alors, il est eh […] presque, le, le, la dernière dune du torrent
I: Oui.
K: Il est un peu plus basse que celle d’à côté.
I: Oui, qui est arrondie.
K: Qui eh. Sur la gauche, la dernière sur la gauche.
K: Donc. L’hôtel est au-dessus, à peu près en face, quoi.
I: Et, à beaucoup de centimètres du pic, ou...
K: Oui, eh, au moins, au moins cinq, eh. Presque I: Ouais d’accord K: il est peut-être à deux centimètres de l’Océan Vert, quoi I: D’accord. A peu près. Donc, une fois que tu est passe devant l’épicier, donc, ça va en diagonale jusqu’à l’hôtel,
I: Oui.
K: Tu passes devant l’hôtel, peut-être à un centimètre eh en-dessous, quoi.
I: En-dessous.
K: Et là, tu remontes tout droit, […] et le but est juste dans le […] ça fait un petit un pf un petit endroit ou ça rentre un petit peu
I: Ouais, un creux?
K: Un creux.
I: Un creux dans l’océan.
K: Donc, le but, c’est juste à un demi centimètre plus bas, quoi.
I: (à un demi centimètre un petit peu plus bas) Et là, je suis arrivée?
K: Et là, t'es arrivée.
I: Et ben, je te remercie. J'ai essayé de ne pas me tromper.
K: De rien. Au revoir.
I: Au revoir.

Ariane (Instruction Giver) and Damien (Instruction Follower):

D: (On se présente? Non? Non, je pense pas.) (A:?) Bon, ben, nous sommes au début, et eh Il va eh falloir que tu m'indiques le chemin, hein. Je sais pas du tout par où passer.
A: Alors, ton début, c'est bien eh vers les maisons obscures.
D: Oui, exactement. Hein, je suis eh au fff on va dire eh nord-ouest des maisons obscures.
A: Nord-ouest. Oui, alors tu contournes les maisons obscures,
D: Par la droite, ou par la gauche?
A: En faisant eh, un « l » un petit peu arrondi.
D: Un « l » un petit peu arrondi. Par la gauche. Ah
A: Tu reviens vers la droite.
D: Oui. Mais je le contourne par la gauche.
A: Si, tu le contournes par la gauche, mais tu reviens vers la droite.
D: D'accord. Ça y est, c'est fait.
A: Et donc, tu vois, il y a un grand abribus.
D: Un grand abribus, oui.
A: Le vois-tu?
D: Je le vois.
A: Alors, il faut que tu fasses une courbe,
D: Une courbe!
A: Alors, j'explique: il faut que tu fasses un « s » à l'envers,
D: Un « s » à l'envers A: C'est-à-dire
A: que ta courbe doit eh doit... Donc, le début.
D: Oui.
A: Ça te fait un « l ». Tu fais une courbe pour toujours être au-dessus du grand abribus,
D: D'accord.
D: A gauche!
A: Voilà. Et tu, continues ta courbe un petit peu légèrement en descendant.
D: Oui.
A: Voilà. Et donc, et cette eh cette ligne, tu la tu la continues jusqu'à eh au verger vert.
D: Jusqu'au verger vert!
A: Oui.
D: Ah. Ben, j'ai un A: T'as pas D: petit problème
A: Tu n'en as pas.D: Je n'arrive pas à voir ou est le verger vert.
A: Alors. Explique: qu'est-ce que tu as?
A: Aah.
D: A gauche de l'abribus, j'ai un Profond Etang.
A: Oui, moi aussi, mais eh j'en ai pas ce château.
D: Ah. Et ou se situe eh ton petit bois vert?
A: Non, le verger vert.
D: Ah, le verger vert.
A: Il se trouve sur la droite du grand abribus, D: mm A: mais, un petit peu en descendant.
D: Un petit peu en descendant. Pff Eh, à quatre, cinq centimètres?
A: Voilà, c'est ça.
D: Bon. Alors, verger vert. Et je passe au-dessus du verger vert?
A: En dessous.
D: En dessous. Donc, je récapitule. Alors, je passe à gauche du grand abribus, en faisant un « s »,
A: Oui.
D: Ah d'accord. En faisant un « s » et j'arrive sur le verger vert.
A: Voilà.
D: D'accord.
A: Voilà. Ça te Ta courbe descend D: Au-dessus,
D: Au-dessus.
A: Au-dessous du verger vert.
D: Au-dessous du verger vert. Ma courbe descend, effectivement.
A: Voilà. Et donc, est-ce que tu as également eh les granges effondrées?
D: Oui, je les vois.
A: Alors, tu continues ta courbe - donc, pas vraiment une courbe - ta ligne,
  jusqu'aux granges effondrées.
D: Jusqu’aux granges effondrées. Ça y est.
A: Voilà.
D: Et ensuite?
D: Ouais.
A: Alors, tu contournes le petit pin.
D: Je contourne le petit pin en passant par la droite? A: Droite. Voilà D: Ah,
  effectivement. D'accord. C'est ce que j'ai fait.
A: Voilà. Et donc, est-ce que tu as une colline?
D: Non.
A: Non.
D: Par contre, j'ai des vastes prairies bien à l'ouest.
A: Moi, je n'en ai point.
D: Ah. Bon. (rire) Il va falloir eh accorder la géographie, hein?
A: Voilà. Alors, une fois que tu as contourne le petit pin, ça te fait un « c » à l’envers à peu près, on va dire, hein?
A: j’aime bien me repérer par rapport aux lettres.
D: Oui, effectivement. Bon.
A: Alors, tu pffff
D: Je descends un peu eh vers le sud de A: Non
A: non non non. Justement, il faut que ça D: Je
D: continues tout droit eh...
A: Non, ça remonte un petit peu.
D: Ah, je remonte un petit peu. Ouais.
A: Il faut que tu fasses une courbe pffff régulière d’environ eh cinq centimètres, à peu près.
D: Ouais, okay.
A: Qui eh qui monte et qui redescend, donc eh, comme une colline, justement. La colline que j’ai.
D: Ah, comme une colline. C’est-à-dire que ta colline se trouve déjà à gauche du petit pin A: oui D: et des granges effondrées,
A: Oui, mais elles se trouvent un petit peu en-dessous.
D: Et alors, elles se trouvent au milieu entre les granges effondrées et le petit pin?
A: Eeeh. D: Environ A: Eeeh
D: Au milieu à gauche?
A: Non, tu reviens un petit peu vers la gauche, mais eh D: Hein. A: Est-ce que tu as une grande plaine?
D: Ouais, j’ai des vastes plaines.
A: Moi, j’en ai une.
D: (Ah bon.)
A: Eeeh Elle est un petit peu eeeh
D: Elle est avant.
A: Ouais ouais. Elle est eh Par rapport au verger vert,
D: Oui
A: Elle est en-dessous. Donc ehm légèrement à droite.
D: Okay.
A: Mais eh, toujours en-dessous du petit pin, également.
D: Ah. Toujours en dessous du petit pin?
A: D’accord.
D: (Hm. Ah Alors. Ben il fallait dire... Oh làlà!) C’est: la colline est en-dessous du petit pin,
A: Eh, elle est eh sur la droite. Pardon, sur la gauche.
D: Sur la gauche en-dessous du petit pin. Voilà, c’est fait.
A: Alors, ça te fait une courbe qui qui fait un un une colline, également.
D: Oui, ben c’est clair, ça.
A: Ouï. Et donc, tu continues, en évitant la grande plaine.
D: J’évite la grande plaine. J’aime pas les plaines de l’ouest.
A: Ça tombe bien.
D: Hm.
A: Alors, eh est-ce que... Donc, tu continues eh normale eh
D: En descendant vers le bas.
A: En descendant D: vers le sud A: vers le
A: vers le bas a... gauche.
D: Gauche, d’accord. Vers l’orfèvre?
A: Voilà! A: C’est parfait! D: Vers l’orfèvre!
D: Bon, je la contourne comment, l’orfèvre?
A: Par la gauche.
D: Par la gauche, ah. Bon ben, c’est fait.
A: Eh donc, tu... ta ligne tu la fff tu la remets un petit peu droite et... Est-ce que tu as
une église romanesque?
D: Oui!
A: Donc, là, tu redescends de nouveau,
D: Mmm.
A: tout à ... en prenant l’église par la gauche, également.
D: l’église par la gauche
A: Alors, ta courbe doit faire D: « o »
A: doit être eh bien arrondi, hein.
D: Bien arrondi (A: ?), parce que, eh, si tu veux, moi, entre eh enfin, à peut-être
deux centimètres de l’église romanesque, sur la gauche de l’église, il y a un
tonnelier.
A: Ah, je n’ai pas de tonnelier, moi.
D: Bon ben, il y a un tonnelier, donc, en fait, il faut que je passe à côté eh... sur la
gauche de l’église en-dessous.
A: Voilà.
D: Bon, c’est fait.
A: Et donc, ta ligne doit être eh, à l’horizontale,
D: Ouais.
A: Et tu la fais retomber un tout petit peu,
D: Mmm.
A: comme une courbe, enfin, comme une courbe normale,
D: Ouais I: D’ail
A: D’ailleurs, il y a le Bel Etang, (jusque?) D: Ah, oui!
D: J’espère qu’il y a une plage, j’aimerais bien me baigner!
A: Et donc eh, tu ... il y a eh la courbe qui continue eh à côté de l’église
romanesque.
D: Oui.
A: Et bien, tu fais une un petit peu une ligne parallèle, tu suis parallèlement, un tout
petit peu
D: Ah, donc je remonte A: Non, non
A: ca te fait pas du tout monter!
D: Ah bon.
A: Non, pas du tout!
D: Bon, ben, alors, attends. Donc, il y a l'iglise romanesque. Là, je suis à l'iglise romanesque.
A: Oui.
D: Bon. J'ai le Bel Etang juste à côté de moi,
A: Voilà.
D: Enfin, (?) point de vue, et, eh, la courbe de l'étang, qu'est-ce que j'en fais?
A: C'est ça D: Je suis la courbe de l'étang? A: Légèrement
D: Mais elle est pas droite, la courbe de l'étang.
A: Mais non!
D: Elle est bosselée.
A: Elle est bosselée.
D: Donc, je suis la bosse?
A: Un tout petit peu D: Un tout petit peu A: sur eh, deux centimètres
D: Bon. Okay, c'est fait.
A: Bon, c'est le but. D: Ah d'accord. A: Tu es /t/! arrive.
D: Ouais, c'est génial! (rire)
A: Voilà, tu est sur le Bel Etang sur la plage tu vas pouvoir te baigner.
D: Ah, merci!

**Damien (Instruction Giver) and Ariane (Instruction Follower):**

A: Bon, je suis au début là.
D: Ah. T'es au début. Bon A: Oui, le début
A: c'est en bas hein? C'est ça.
D: Le début est bien en bas, une station balnéaire, hein
A: C'est ça.
D: Hein, tu es au camping de la station.
A: Je suis au camping de la station?
D: Oui, on va dire comme ça.
A: Ah d'accord. D: t'es
D: pas dans le centre ville de la station. Donc, comme tu vois la station là, le centre ville de la station,
A: Oui
D: Tu vas comme tu, ben, Tu vas passer la station sur ta droite. Non, sur la gauche de la station, eh A: Oui,
A: je me rapproche un peu, quand même?
D: Tu te rapproches un peu et tu eh Voilà,
A: Je monte
D: tu montes, en fait tu longes
A: Ouais
D: tu longes la côté, mais eh en passant à gauche la station balnéaire.
A: D'accord.
D: Hein? Tu montes, tu continues à monter,
A: Oui.
D: eh tu passes à côté du nouveau phare,
A: Ah, donc, je contours la station par la gauche?
D: Non, oui, voilà, tu passes par la gauche de la station, Hein?, avec un trait plus ou moins parallèle à la côté, Hein?. Tu passes à côté du nouveau phare qui est sur la côté,
A: Toujours par la gauche? D: Toujours eh par la
D: par la gauche, hein.
A: D’accord. Et une fois que je suis passe à côté du...
D: Hein? Alors, eh, une fois que t’es passe à côté du nouveau phare. Alors, un petit peu plus au nord, il y a un ancien abri antiatomique.
A: Ah. Et il est ou, ton abri atomique?
D: A côté des forets immenses.
A: D’accord.
D: Bon, alors il y a à gauche des forets immenses A: Oui, d’acc... D: peut-être à un centimètre.
A: D’accord. Ça s’appelle « ancien abri atomique »? D: Oui, c’est
D: un ancien abri atomique, antiatomique.
A: (rire) Evidemment.
D: (on voit bien) Bon, alors, donc, t’as ton ancien abri antiatomique, avec [III] des forets immenses à côté
A: Oui
D: Donc, tu passes au milieu.
A: Au milieu.
D: Hein? C’est tout simple!
A: Pour l’instant, oui.
D: Alors, là, ensuite tu fais, Ah. Est-ce que tu vois au nord des champs inondés A: oui D: sur la gauche
A: oui sur la gauche
D: et des torrents effroyables A: effroyables D: sur la droite?
A: Voilà, oui!
D: Tu les vois?
A: Je les ai.
D: Bon, eh ben, tu passes en plein milieu de tout ça, A: Ah, bon, d’accord D: avec une tendance vers le nord.
A: D’accord
D: Bon, mais
A: Ah Oui?
D: au milieu, mais, plus quand même eh, sss du côté des champs inondés.
A: Ah mais ça tombe bien, ça tombe bien D: Parce que
D: la route est quand même beaucoup plus praticable du côté des champs inondés.
A: Plutôt(?) que dans des torrents effroyables, D: hmm A: ou il y a D: Mmm A: la montagne et tout ça, hein?
D: Ouais, c’est, là, c’est vraiment, puis eh c’est les sentiers, c’est des sentiers dans des torrents effroyables, hein?
A: Ah oui!
D: Ouais, c’est, c’est pas bon, non non.
A: Ah Oui Voilà, j’ai t.. est-ce D: Alors,
D: Bon, tu les longes, ces champs inondés, parce que tu vas quand même pas te baigner dedans,
A: Non.
D: Et, tu vas arriver du côté de deux fermes abandonnées.
A: Et elles se trouvent ou, tes fermes abandonnées? D: Ah
A: A côté d’un certain désert sec?
D: Un désert sec? A: Ah. Tu n’as pas le désert sec!
D: Ah, ben non, j’ai pas de désert sec, là, hein. Ça fait un peu désert des Tartares. Alors. Comment expliquer?
A: Eh ben eh, Moi, pour t’expliquer ou se trouve le désert sec, D: Oui A: il se trouve au-dessus des torrents effroyables et les champs inondés, D: Mmm A: mais vraiment au milieu de tout ça.
A: Oui.
D: Tu vois les champs inondés?
A: Oui.
D: La plus gros bosse des champs inondés.
A: Oui.
D: Alors, légèrement sur ta gauche, environ peut-être eh trois centimètres,
A: Ouais.
D: tu as les deux fameuses fermes abandonnées.
A: En haut sur la gauche?
A: D’accord. D: Donc,
D: Tu remontes en passant à côté de ces fermes, et ensuite, tu montes au nord.
A: Et est-ce D: vers la bourgade rurale.
A: Ah, j’ai toujours pas ça, moi.
D: T’as toujours pas de bourgade rurale. Bon. Alors, c’est c’est A: Est-ce A: que tu as un hameau tout en haut?
D: Non, j’ai pas de hameau. (A: Alors) D: Ah! Tout en haut sur la gauche, là!
A: Oui.
D: Hein, au coin?
A: Voilà!
D: Et la bourgade, c’est juste en-dessous. Pile en dessous, pile poids en-dessous.
A: D’accord. Attends D: Bon A: Deux secondes. Et donc, est-ce que je passe à gauche de la bourgade?
D: Non, tu passes à droite de la bourgade, en montant alors Ah ben, là, ou en fait, là ou t’as placé les fermes abandonnées,
A: Oui.
D: La bourgade, c'est dans en nord, c'est nord,
A: Oui.
D: à d trois centimètres.
A: D'accord.
D: Donc, tu montes eh directe, hein?
A: D'accord.
D: Tu montes tout droit.
A: Voilà.
D: Ensuite, tu vas avoir sur ta droite, un bon petit épicier.
A: Oui.
D: Hein?
A: Oui.
D: Donc, tu le contournes par le haut
A: Par le haut.
D: Par le haut, hein.
A: Et je redescends?
D: Ensuite, tu redescends,
A: Hmm.
D: et là, comme t'es fatiguée et que eh pf Bon. Tu veux te renseigner, il y a un ancien hôtel.
A: Ah bon!
D: Oui.
A: A peu près à combien de centimètres par rapport au bon épicier?
D: Ah, ben, là, il faut faire un petit peu de chemin,
A: Un petit peu, oui.
D: On va dire, eh, toujours quatre centimètres, et eh A: Sud-ouest,
A: sud-est?
D: Eh sss oh, sud-est, hein.
A: Sud-est D: Sud-est
D: Quatre centimètres sud-est.
D: Ouais, un ancien hôtel, eh, une maison typique du coin, hein?
A: D'accord.
D: Qui a du cachet. Alors, A: Et donc, je D: cet ancien hôtel, eh, tu le contournes, mais à cette fois-ci par le bas.
D: Alors, une fois que tu l'as bien contourné,
A: Oui
D: Hein?
A: Je remonte?
D: Tu remontes nord,
A: Nord.
D: Et, tu arrives à un moment à la côté là, de l'Océan Vert, mmmm
A: Eh, au milieu de la bosse, ou...?
D: Ouais, voilà A: ou... D: voilà. C’est ça.
A: D’accord.
D: Et puis voilà.
A: C’est là.
D: Voilà, t’es arrivée.
A: Ouais!
Appendix D

Comparison of original F0 traces and retracings

A number of fundamental frequency traces taken from the corpora have been included to make the argumentation in Chapters 5 and 6 more transparent to the reader. Whenever only the pitch movement is at issue, the original fundamental frequency traces are presented as retracings. Retracing has the advantage that the realisations of several speakers can be presented in one figure for ease of comparison, and that it saves disk space. The original fundamental frequency traces were produced by means of the Entropic waves+™ signal processing package on a Silicon Graphics Indy™ workstation, and saved as BMP files. They were transferred to a PC and included in a Word 97 document. The Word 97 drawing facility was used to retrace the fundamental frequency trace of each BMP file. The figure below shows that the original fundamental frequency traces and the retracings are extremely similar.

Comparison of the original fundamental frequency trace (top) and the retracing (bottom) for *Cendrillon lui avoue tous ses malheurs* ‘Cendrillon tells her of all her troubles’. Grey shading indicates the accented syllables, which are underlined in the phonetic transcription.
Appendix E

Excerpts of the score forms used in the Categorical Perception experiment and the semantic task (Chapter 7)

Identification

I. Instructions:
Dans cette expérience, vous devrez décider si la prononciation d'une phrase ressemble plutôt à la prononciation nommée A, ou plutôt à l'autre, nommée B. Vous entendez d'abord toutes les phrases A :

A
Mélanie vit normalement
Elle les avale oralement
On l’a ému moralement

Et maintenant il y a les mêmes phrases, prononcées comme B :

B
Mélanie vit normalement
Elle les avale oralement
On l’a ému moralement

Avez-vous perçu la différence entre A et B? Pour la rendre encore plus évidente, vous les entendez dans une paire (AB):

A
Mélanie vit normalement
Elle les avale oralement
On l’a ému moralement

B
Mélanie vit normalement
Elle les avale oralement
On l’a ému moralement

Exercice :
Maintenant, pour vous exercer, vous entendrez quatre phrases de suite. Vous devrez indiquer si la prononciation de la phrase ressemble plutôt à A ou à B en marquant la case d'une croix. Vous entendrez chaque phrase deux fois, et ensuite vous aurez 3 secondes pour faire votre choix.
Dans le test suivant, vous entendrez d’abord le contraste A – B, suivi de 10 phrases test, une répétition de ce contraste, suivi encore de 10 phrases test, et ainsi de suite. Tenez compte du fait que le nombre de fois que vous choisissez A ou B ne sera pas forcément ‘équilibré’. Vous allez probablement opter pour B plus souvent que pour A, mais ce n’est pas grave. Il est donc théoriquement possible que vous entendiez 10 fois de suite l’option B. Pour cette raison, résistez à la tentation de choisir même A quand vous optez à première écoute pour B! L’inverse est tout à fait possible aussi. Le test prendra environ 25 minutes. Merci et bon courage!

Test I:

Contraste: On l’a ému moralement

La phrase ressemble plutôt à

A B

1.  
2.  
3.  
4.  
5.  
6.  
7.  
8.  
9.  
10.  

Contraste: Mélanie vit normalement

La phrase ressemble plutôt à

A B

11.  
12.  
13.  
14.  
etc.
Discrimination

Instructions:

La prononciation des phrases est

<table>
<thead>
<tr>
<th>Phrase</th>
<th>IDENTIQUE</th>
<th>DIFFERENTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mélanie vit normalement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Elle les avale oralement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. On l’a ému moralement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Elle les avale oralement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. On l’a ému moralement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Des exemples donnés ci-dessus, les membres des paires 3 et 5 étaient identiques, et les autres étaient différents. Alors, les différences que vous devez percevoir sont très subtiles. Pour cette raison, choisissez la case ‘différente’ si vous hésitez. Dans le test, vous trouverez probablement qu’il y a beaucoup de paires qui semblent identiques. Comme les différences n’ont pas été également réparties dans le test, vous pouvez trouver de longues séries de paires que vous jugez être identiques.

Pour vous aider à vous souvenir où vous en êtes sur le formulaire de scores, les phrases seront présentées dans des blocs de cinq paires, et chaque bloc sera suivi d’un bip sonore. Le test prendra environ 35 minutes.

Merci et bon courage!

Test:

La prononciation des phrases est

<table>
<thead>
<tr>
<th>Phrase</th>
<th>IDENTIQUE</th>
<th>DIFFERENTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;bip&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Semantic task

Instructions:
Dans cette expérience, votre tâche est d'évaluer la connotation d'un certain nombre de contours mélodiques. Les contours mélodiques ont été prononcés sur les mêmes phrases que vous avez entendues auparavant. Tout d'abord, vous devrez juger si la locutrice semble sûre de ce qu'elle dit. Vous entendrez une paire de phrases, A et B, dont la mélodie est légèrement différente, et vous devrez déterminer dans quelle phrase la locutrice semble plus sûre de ce qu'elle dit. Alors, vous marquerez d'une croix la case de la phrase la plus sûre.

Exercice:
Pour vous familiariser, vous entendrez 6 paires de mélodies de suite. Pour chacune de ces paires vous devrez indiquer si c'est dans A ou B que la locutrice semble la plus sûre de ce qu'elle dit. Tenez compte du fait que les paires ne seront pas répétées dans cette partie de l'expérience. C'est à dire que vous avez moins de temps qu'avant pour réfléchir sur votre décision.

La locutrice semble PLUS SÛRE de ce qu'elle dit dans

1. A □ B □
2. A □ B □
3. A □ B □
4. A □ B □
5. A □ B □
6. A □ B □

Dans le test, il y a aussi des paires de contours mélodiques qui sont identiques. Dans ce cas, vous choisissez la case ‘identique’. Pourtant, n'optez jamais pour ‘identique’ si vous percevez une différence entre A et B. Dans ce cas-là, il faut toujours choisir entre A et B, même si c'est difficile. Pour vous aider à vous souvenir où vous en êtes sur le formulaire de scores, chaque série de 6 paires de phrases sera suivie d'un bip sonore. Le test prendra environ 25 minutes. Merci et bon courage.
Test I:

La locutrice semble PLUS SÛRE de ce qu'elle dit dans

1. A □ B □ A et B sont identiques □
2. A □ B □ A et B sont identiques □
3. A □ B □ A et B sont identiques □
4. A □ B □ A et B sont identiques □
5. A □ B □ A et B sont identiques □
6. A □ B □ A et B sont identiques □

<bip>

7. A □ B □ A et B sont identiques □
8. A □ B □ A et B sont identiques □
9. A □ B □ A et B sont identiques □
10. A □ B □ A et B sont identiques □
11. A □ B □ A et B sont identiques □
12. A □ B □ A et B sont identiques □

<bip>

etc.
Samenvatting

Sprekers kunnen variaties in toonhoogte gebruiken om betekenisverschillen aan te geven. De intonationele fonologie is de tak van taalkunde die zich bezighoudt met de structuur van deze toonhoogteveranderingen. Dat wil zeggen dat men probeert contrastieve verschillen in toonhoogte te onderscheiden van graduele verschillen, zodat een inventaris gemaakt kan worden van de intonatiecontouren van een taal.

De centrale vraag die in dit proefschrift gesteld wordt is: Wat zijn de intonatiecontouren van het Frans? In de tamelijk uitgebreide literatuur over Franse intonatie heeft deze vraag vaak tegenstrijdige antwoorden gekregen. Sommige onderzoekers zien intonatiecontouren als holistische eenheden die zich over een stuk zin (een domein) uitstrekken. Men concentreert zich dus voornamelijk op de richting waarin de toonhoogte verandert. Anderen gaan ervan uit dat intonatiecontouren uit draaipunten bestaan die met beklemttoonde lettergrepens of domeingrenzen samenvallen. In dit geval is voornamelijk het moment waarop de toonhoogte verandert van belang. Wanneer een verschil tussen twee toonhoogtebewegingen in de ene benadering wel en in de andere benadering niet beschreven kan worden kan dit tot verschillende inventarissen van intonatiecontouren leiden. Een andere reden waarom Franse onderzoekers tot verschillende conclusies komen is dat sommigen zich op hun intuities baseren, en anderen op empirisch onderzoek.

In dit proefschrift wordt geprobeerd de vraag te beantwoorden door empirisch te onderzoeken (a) welke vorm veranderingen in toonhoogte kunnen aannemen in het Frans en (b) waar deze veranderingen voorkomen. Het resultaat is een beschrijving van de tonale structuur van het Frans en de oplijning van deze structuur met de ‘tekst’ (de segmentele structuur). In de tonale analyse beperkt een inventaris van twee accenten en vijf grenstonen het aantal contrasten dat gegenereerd kan worden. Deze fonologische (abstracte) tonen worden met beklemttoonde lettergrepens of domeingrenzen opgelijnd en fonetisch geimplementeerd (ze krijgen bepaalde waarden in tijd en fundamentele frequentie). Omdat de fonologie en de fonetiek van elkaar worden gescheiden (intonatiele contrasten tegenover graduele verschillen in toonhoogte) doet de beschrijving duidelijke voorspellingen over de aard van verschillen tussen intonatiecontouren (contrastief of niet), en die voorspellingen kunnen getoetst worden.

De beschrijving van de oplijning tussen de tonale en de segmentele structuur beperkt het aantal intonatiecontouren dat gegenereerd kan worden nog verder. De beschrijving geeft aan hoe een aantal factoren bepaalt met welke lettergrepens accenten worden opgelijnd. Zo doet ook dit model duidelijke voorspellingen

1 Met beklemttoonde lettergrepens worden metrisch sterke lettergrepens bedoeld, en de term accent wordt hier gebruikt voor beklemttoonde lettergrepens die door een verandering in toonhoogte gemankeerd worden (stress versus pitch accent elders in het proefschrift).
waarmee het toetsbaar is. De keuze die hier is gemaakt voor de benadering die
intonatiecontouren als een serie draaipunten analyseert (de fonologische tonen) is
mede gebaseerd op de bevinding dat frasering (de opdeling van een zin in
woordgroepen) een cruciale rol speelt in de distributie van accenten.

Hoofdstuk 1 leidt de onderzoeksvragen van de studie in door een aantal
uitgangspunten in de intonationale fonologie aan de orde te stellen. Cruciaal voor dit
proefschrift is de aannemen dat intonatiecontouren een fonologische structuur
hebben. Om die structuur te kunnen beschrijven moet vastgesteld worden wanneer
veranderingen in toonhoogte plaatsvinden, hoe de toonhoogte op die plaatsen
veranderd wordt, en tenslotte, welke veranderingen tot een contrast leiden.

In hoofdstuk 2 wordt een overzicht gegeven van de theoretische benaderingen
die zijn toegepast in de beschrijving van de intonatie van het Frans. De keuze voor
de Autosegmenteel-Metrische benadering die in dit proefschrift is gemaakt wordt
gemotiveerd.

De resultaten van het produktie-experiment in Hoofdstuk 3 laten zien dat de
distributie van accenten in het Frans bepaald wordt door de Fonologische Frase, een
prosodisch domein dat afgeleid is van de morpho-syntactische structuur. De
Fonologische Frase wordt aan de rechterkant verplicht gemarked door een accent;
niet-finale accenten zijn optioneel. Wanneer twee accenten elkaar direct opvolgen
binnen een Fonologische Frase wordt het eerste accent verplaatst of weggelaten (bv.
de jolis airs of de jolis airs i.p.v. de jolis airs; het proces wordt hier Clash
Resolution genoemd).

Het experiment onderzocht de toepassing van Clash Resolution en Liaison. Om
onafhankelijke evidentie voor de gerealiseerde frasering in het experiment te hebben
werden duurmetingen verricht. De hypothese was dat beide processen door de
Fonologische Frase geconditioneerd worden. Dat wil zeggen dat allebei de
processen toegepast worden binnen het domein, maar niet over de domeingrenzen
heen. Clash Resolution gedroeg zich conform de hypothese. Het werd alleen
toegepast binnen de Fonologische Frase, ook in gevallen waarin meerdere
Fonologische Frases samengevoegd werden (‘herstructurering’). Alleen toonden
zowel de duurmetingen als de toepassing van Clash Resolution (ondersteund door
aanvullende metingen) aan dat de regels die voor herstructurering in de literatuur
zijn voorgesteld niet helemaal kloppen. De aanvullende metingen bevestigden
bovendien dat het niet-finale accent in Clash Resolution gevallen weggelaten kan
worden - de realisatie van een accent eerder in de Frase is optioneel, wat pleit voor
een deletie analyse. Het tweede proces, Liaison, bleek niet door de Fonologische
Frase geconditioneerd te worden. De gevallen waarin Liaison werd toegepast
kwamen niet met die van Clash Resolution overeen, en ze stroomden niet met de
duurmetingen. Een voorstel voor een alternatieve analyse van Liaison als een
syntactisch gebonden lexicaal insertieproces sluit het hoofdstuk af.

In Hoofdstuk 4 wordt de complexe interactie tussen Fonologische Frasering en
accenttoewijzing beschreven in Optimality Theory. De factoren die de distributie
van accenten bepalen worden uitgedrukt als elkaar beconcurrerende universele
principes van 'welgevormdheid', zoals NOCLASH dat zegt dat twee opeenvolgende lettergrepen niet tegelijkertijd geaccentueerd mogen worden, en RIGHTMOSTPWD, dat ervoor zorgt dat prosodische woorden een finaal accent hebben. Als de principes ('constraints') met elkaar in conflict zijn bepaalt hun onderlinge rangorde welk principe het 'wint'. Deze rangorde ligt in de grammatica van de taal vast. Zo kan het bijvoorbeeld voorkomen dat een woord toch zonder finaal accent wordt gerealiseerd (b.v. de jolis airs is beter dan de jolis airs – NOCLASH wint het van RIGHTMOSTPWD).

Variatie in accentpatronen en frasering onder invloed van bijvoorbeeld verschillen in spreek snelheid en -stijl worden beschreven met behulp van gedeeltelijke ordening ('partial ranking'). Omdat subgroepen van constraints niet onafhankelijk zijn ten opzichte van elkaar is meer dan één vorm mogelijk (de varianten), maar omdat zo'n subgroep wel ten opzichte van de andere constraints geordend is worden ongrammaticale vormen toch uitgesloten. Op deze manier kan talavariatie met behulp van hetzelfde grammaticale systeem beschreven worden als 'normale' spraak.

In hoofdstuk 5 worden de toonhoogtebewegingen in een corpus spontane en gelezen spraak onderzocht om vast te stellen welke verschillen in toonhoogtecontrastief zijn, en dus in de fonologie beschreven moeten worden. De auditieve en akoestische analyse van de corpora leidde tot een eerste indeling in intonationcontouren, die vervolgens vergeleken werd met beschrijvingen in de literatuur. Op grond hiervan werd een inventaris van zeven contrasteerderende contouren aan het einde van de Intonationele Frase opgesteld, en drie in niet-finale positie. De realisatie van de contouren bleek vaak te variëren wat betreft (a) toonhoogterichting aan het begin van de contour (stijgend, dalend of vlak), (b) timing van het hoogste en laagste punt in de contour, en (c) de afstand tussen het hoogste en laagste punt van de contour.

De contouren uit het inventaris worden in een Autosegmenteel-Metriscbe kader geanalyseerd in Hoofdstuk 6. Op het fonologisch niveau zijn de volgende tonale specificaties gedefinieerd: (a) de accenten H* en H+H*, (b) de grensspecificaties voor de Intonationele Frase %L en %H (linkergrens), L%, H% en 0% (rechtergrens), en (c) een L-toon die optioneel tussen twee hoge gesterde tonen ingevoegd kan worden. Deze specificaties vormen fonologisch contrastieve intonationcontouren wanneer ze met de segmentele structuur worden opgelijnd. De grammatica in (1) geeft de tonale specificatie van een Intonationele Frase (de tonen waaruit in een bepaalde positie gekozen kan worden staan tussen accolades, ronde haken geven optionele elementen aan en H*(L) kan herhaald worden op iedere niet-finale beklemtoonde lettergreep).

(1) De Intonationele Frase: \[
\begin{align*}
\{ %L \} & \quad (H^* (L))_0 \\
\{ %H \} & \quad H^* \\
\{ H + H^* \} & \quad \{ L\% \} \\
\{ H\% \} & \quad \{ 0\% \}
\end{align*}
\]
Op fonetisch niveau wordt de toonreeks omgezet in doelwaarden met een bepaalde fundamentele frequentie en timing. De doelwaarde van een H* die direct op een hoge toon volgt wordt automatisch gedownstept (lager gemaakt), behalve wanneer de H* door een hoge grenston toon wordt gevolgd. Spreiding beschrijft fonetische varianten waarin de toonhoogte op het niveau van de voorafgaande tonale specificatie blijft.

De bespreking van een aantal alternatieven voor deze analyse laat zien dat ze de verkeerde voorspellingen doen of omslagtijger zijn. Aan het eind van het hoofdstuk wordt de analyse vergeleken met de andere Autosegmenteel-Metrische beschrijvingen die voor het Frans zijn opgesteld. De volgende punten komen daaruit naar voren.

I. In ons voorstel kan een klein aantal specificaties alle intonatietoontonen beschrijven.

II. Alleen tonen met een fonetische realisatie worden in de fonatologie beschreven.

III. Het is niet nodig om een fonologisch onderliggende van een fonologische oppervlaktestructuur te onderscheiden.

IV. Het verschil tussen accenten aan het begin en aan het einde van een woord hoeft niet in de aard van de tonen verantwoord te worden, maar volgt uit hun verschillende luidheid met de prosodische structuur.

V. Vanwege het duidelijke onderscheid dat tussen de fonetiek en fonologie gemaakt wordt voorspelt de beschrijving welke toonhoogteverschillen contrastief en welke gradueel zijn, wat getoetst kan worden.

Om de analyse te ondersteunen werden twee perceptie-experimenten uitgevoerd die verslagen worden in Hoofdstuk 7. De vragen waren: (a) Kan het onderscheid in eindstijgingen tussen H*H% en H*0% experimenteel worden bevestigd? (b) Kan binnen één fonologische categorie een fonetisch verschil in toonhoogte verschillende attitudes of emoties tot uitdrukking brengen? Als fonetische variatie soms inderdaad betekenisdragend blijkt te zijn in Franse intonatiecontouren, dan zou dat deels kunnen verklaarden waarom men het niet eens is over hun aantal en vorm.

De eerste vraag werd onderzocht met behulp van het Categorisch Perceptie paradigma (CP). De hypothese was dat het verschil tussen H*H% en H*0% voornamelijk wordt gerealiseerd als een verschil in piekhoogte, en dat verschillen in timing en richting (vlak of stijgend op de laatste lettergreep) gradueel zijn. Hoewel de resultaten van de identificatietoontonen onze hypothese bevestigden, deed de discriminatietoontonen dat niet. Bovendien droeg één van de controlecondities zich niet volgens de voorspellingen. De resultaten zijn dus onbetrouwbare. Misschien worden intonationele contrasten niet categorisch waargenomen, en in dat geval is CP geen geschikt paradigma voor dit type onderzoek.

De tweede vraag werd via een semantische taak onderzocht, waarin luisteraars beoordeelden hoe zeker of verbaasd een verschil in toonhoogte klonk. Een later begin van de eindstijging, wat volgens ons model een gradueel verschil in timing is, bleek minder verbaasd en zekerder te klinken dan een vroege stijging. Deze effecten waren kleiner dan die in de conditie waarin een stijging langzaam in een stijg-daling werd veranderd, wat twee fonologische categorieën zijn in het Frans. Graduele
verschillen kunnen dus interpretatie beïnvloeden, maar omdat de effecten in de graduele conditie tamelijk klein waren lijkt het onwaarschijnlijk dat het verschil in timing de grammaticale functie van de stijging zou kunnen veranderen (en daarmee in de fonologie beschreven zou moeten worden).

De discussie aan het einde van het hoofdstuk stelt de volgende punten aan de orde.

I. Hoewel de resultaten van het CP experiment tegenvielen, stroken de resultaten van beide experimenten met onze hypothese dat $H^*H^%$ en $H^*O^%$ contrasteren.

II. Een beschrijvingsmodel waarin fonetiek en fonologie van elkaar worden gescheiden is bij uitstek geschikt om de semantische effecten uit het tweede experiment te beschrijven.

Hoofdstuk 8 vat het proefschrift samen en bespreekt de reikwijdte en implicaties van de studie.
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