The Prosodic Structure in French: Properties and Constraints.

In this lesson we will attempt to formalize the properties of the prosodic structure and define its relationship with the syntactic structure of the sentence applied to French data.

Relations of dependency

To characterize the properties of the prosodic and syntactic structures we will need a set of 4 dependency relations:

A -> B   A depends of B on the right, A selects B on its right, B precedes A;
   Ex.: *Une charmante soirée* (*une soirée* can appear without *charmante*)

A <- B   B depends on A on the left, A is selected by B on its right, A precedes B;
   Ex.: *Pierre déjeune* (*Pierre* can appear without *déjeune*)

A – B   A and B are independent from each other; A can occur without the presence of B, B can occur without the presence of A;
   Ex.: *Hier, Marie* (*Hier* and *Marie* can appear independently)

A <-> B   A and B are symmetrically dependant, A cannot occur without the presence of B and B cannot occur without the presence of A. In *la table* the article *la* depends on the noun *table*.
   Ex.: *il partait* (*il* and *partait* can not appear independently)

In the syntactic structure, A and B stand for minimal units such as lexemes, or syntactic groups as SN or SV; in the prosodic structure, A and B represent minimal prosodic units or stress groups.

A prosodic word, minimal unit of prosody organized hierarchically by the prosodic structure, contains one and only one lexical stress. It is also called a stress group. A clear understanding of stress assignment rule in French is thus pivotal in the discussion on prosodic structure.

Intonation model: any linguistic role for intonation?

An intonation model is an instantiation of a hypothetical-deductive process. To illustrate this, let's start with the simple and well-known correlation existing between intonation and the sentence modality.

The sentence establishes a specific relationship between the speakers and the other participants of the speech act. This relationship, called the modality, can be a priori classified according to various grids and classes, from the simplest involving declaration and interrogation, to more complex ones involving subtle degrees of social relationship, of speech act context, etc. In most in not all languages, various markers, syntactic, morphologic, as well as the tone of voice indicate sentence modality.

In the simplest case, sentence modality can be either declarative or interrogative. So the classes of relationship between the speaker and the audience are reduced to either delivering information or requesting information. The traditionally imperative modality is therefore appears as a variant of declaration (the lack of proper imperative form in the verb system in French gives other arguments to consider imperative as a variant of declaration).

Consider the following example *tu viens* pronounced in some neutral context:

Declarative   *tu viens.*   Interrogative: *tu viens ?*

The absence of other markers (syntactic, morphological, contextual) forces intonation to function as the only marker of the declarative or interrogative modality. We can then expect to discover some significant differences between the two melodic contours correlated with these modalities, differences manifested by prosodic data. To find out which are the features involved, we have to turn to experimental data. If we are not willing or capable to distinguish and qualify these differences by ear, we can then ask for the help of modern technology, i.e. to the acoustical analysis of the sentence, which should reveal quickly where the differences are. The following figure shows the result of acoustical analysis of a speech example, displayed with time on the horizontal and frequency on the vertical axis.
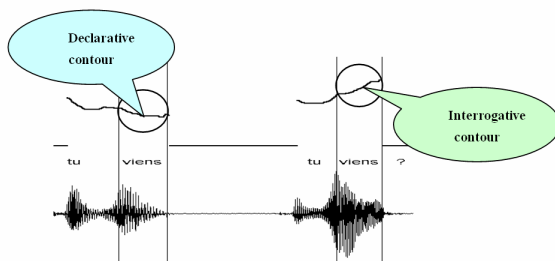

Figure 1: Fundamental frequency contour (in black) for declarative and interrogative

At this point, we introduce an important constraint in our way to look at the data. We will introduce a "filter" that would extract from acoustical fundamental frequency, intensity and duration only segments corresponding to (effectively) stressed syllables. Those parameters have been shown for a long time to be encoding stress in most languages, and stressed syllables are be the key feature of a unit introduced later, the prosodic word. In fact, stress is central as always present even when the sentence is reduced to a minimal form with a sequence of syllables containing one stress, or just one syllable, necessarily stressed.

Our simple example has two syllables, and the last one (as French phonology predicts) is stressed. Opposing the acoustic manifestations of the declarative and interrogative modalities, the most prominent acoustic feature appears to be fundamental frequency, falling in the declarative case and rising for interrogative. If Rising is chosen as marked feature of the modality contour, we have then the following simple system:

Declarative	Interrogative
- Rising	+ Rising

As all other phonological markers, the modality contour can be neutralized in its function if another marker of modality is present in the sentence. This is the case if the so-called imperative morphological form is used for the verb, as in *viens* and when the inversion subject-verb or the *est-ce que* locution is used to indicate the interrogative modality of the sentence *viens-tu ?   est-ce que tu viens ?*

Its function being suspended as redundant, the melodic contour does not have to manifest the feature + Rising, as shown on the following acoustical curve
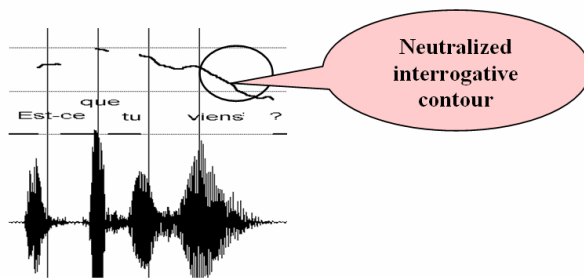

Figure 2: Fundamental frequency curve for neutralized interrogative modality contour

Modality and propos-thème

The sentence (i.e. here the phrase, or text, associated with the prosody, or tune) is not produced in a vacuum, but rather in a specific *context* (all the information contained in sentences produced earlier) and a specific *situation* (all the information known by actors in the speech act). Among other languages, French has a mechanism involving sentence

intonation to mark that a part of the sentence contains information already known by the speech participants.

This process divides the sentence into two parts, the *thème*, containing information already presented either in the context or in the situation of the speech act, and the *propos*, with the propos always preceding the thème. An example of this division is *Maximilien est venu* as a declarative sentence answering a question such as *qui est venu ?*, or as an example of the opposite interrogative modality, a question as *Maximilien est venu ?* following a statement like *quelqu'un est venu*.

In both cases, a specific stress, manifested by a specific contour, appears on the last syllable of the propos *Maximilien* to mark the division of the sentence into *propos* and *thème*. If the conditions of such a division into propos and thème are not met, the stress located on the last syllable of *Maximilien* is realized differently (or neutralized, as we will see later).

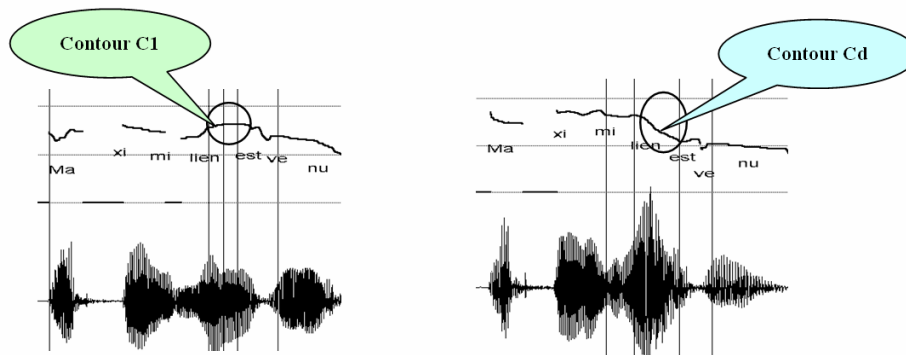| Declarative		Interrogative	
Context	Sentence	Context	Sentence
Qui est venu ?	*Maximilien est venu.* **PROPOS** THÈME	Quelqu'un est venu.	*Maximilien est venu ?* **PROPOS** THÈME
------------------	*Maximilien est venu.* PROPOS	----------------------	*Maximilien est venu ?* PROPOS

Figure 3: Fundamental frequency curves without and with propos-thème division of the sentence, declarative case.
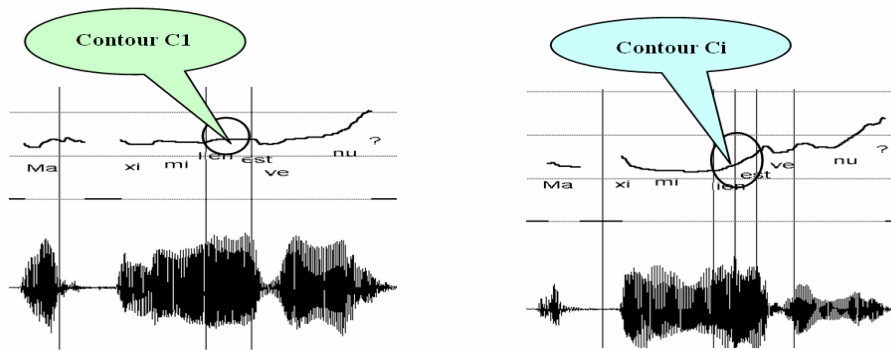
Figure 4: Fundamental frequency curves without and with propos-thème division of the sentence, interrogative case.

Stress group and destressing in French

The minimal unit of prosody in French is the stress group (also called rhythmic group or prosodic word). Usually, in most discussions on stress, stress group is defined as a "sense group" (with no formal definition), of a pragmatically user defined rhythmic entity. Let's consider a more formal approach to define the stress group. To achieve this, we will need the concept of stressability, a property of a syllable or a larger unit to optionally receive stress. We will then have stressable syllable, stressable words.

Closed list (grammatical) words are non stressable and that open class (content) words are stressable. Pronouns, conjunctions, prepositions, verb auxiliaries will not be stressable. Nouns, verbs, adjectives and adverbs will be stressable.

Stress group formation principle

Now these stressable words form with adjacent non stressable words a rhythmic (or stress) according to the dependency relations with the stressable word involved. Non stressable words are either in selection or in solidarity with the content word in the group.

Units in solidarity and in selection with the open class word belong to the same stress group. The following examples, with their internal dependency relations displayed, illustrate this rule (stressed syllables are underlined in red).

Solidarity, less than 7 syllables one stress on the last pronounced syllable.

Solidarity between *je* and *donne*, 2 clitic pronouns *le* and *lui* select the verb

Same as preceding example, with the negation particles *ne* and *pas* in solidarity, selecting the verb, and a total of 6 syllables. The last pronounced syllable receives the stress.

The next set of examples show clitic pronouns, selecting a verb at compound past tense with auxiliary *ai* and past participle with 1, 2 and syllables *pris*, *donné*, *présenté*, with the negation particles *ne* and *pas* in solidarity. Due to the transitivity of solidarity relation, the pronoun *je*, *ai* and the past participle form one group will all its elements in solidarity

The stress patterns of these 3 examples illustrate the effect of 2 other rules to explain the distribution of stress in these sequences.

1. The 7 syllables rule, which prevent the occurrence of more than 7 consecutive syllables without one being stressed (the actual number of consecutive unstressed syllables depends on the speech rate).

2. The stress clash condition, preventing the occurrence of two consecutive stressed syllables, unless some articulatory or pause distance is inserted between them. This condition applies only if corresponding syntactic units are dominated by the same node in the syntactic structure.

In *je ne le lui ai pas pris*, all the elements form one stress group according to the group formation principle. The number of syllables is 7, and complies with the 7 syllable rule.

The next stress group, *je ne le lui ai pas donné*, with the same internal structure, has 8 syllables. Another syllables has thus to be stressed in the sequence. The extra stress can be placed as an emphatic stress (narrow focus) on any of the pronouns *le* or *lui* in selection with the verb. This stress is emphatic since it does not comply with another stress assignment principle:

3. Lexical stress is assigned in priority to elements located at the highest levels in the prosodic structure.

The highest element in these examples is the second part of the negation *pas*. Stress on *pas* does not appear emphatic in *je ne le lui ai pas donné* or in *je ne le lui ai pas présenté*, it simply results from the 7 syllable principle. In *je ne le lui ai pas pris* however, with 7 syllbles, stress on *pas* provokes a stress clash with the stress on *pris*, and will then appear as emphatic.

As we will see later, stress will indirectly, through the mechanism of the principles stated above, induce disambiguation between distinct syntactic structures. Consider the sentence *Julien adore le café chaud*, where the adjective *chaud* can modify the verb phrase *adore le café* (interpretation a), or simply be part of the noun phrase *café chaud* (interpretation b).

Here another rule applies: the syntactic clash rule (Martin, 1987). Ina), *café* and *chaud* do not belong to the same prosodic group formed with 2 distinct stress groups. Indeed, each stress group *café* and *chaud* (a noun and an adjective) is dominated by distinct nodes in the syntactic structure, whereas in b), the same node dominates them. In a) the stress clash condition does not apply, and *café* is stressed on its last syllable. In b), the condition applies and stress clash forces the last syllable stress to move on the first syllable of *café*.
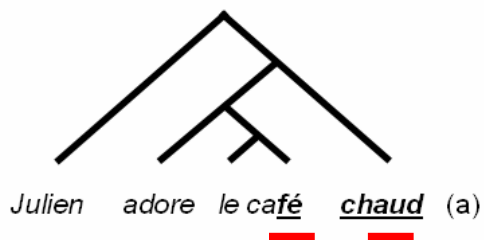
No stress clash, since the 2 units with successive stressed syllables *café* and *chaud* are dominated by distinct nodes in the syntactic structure.
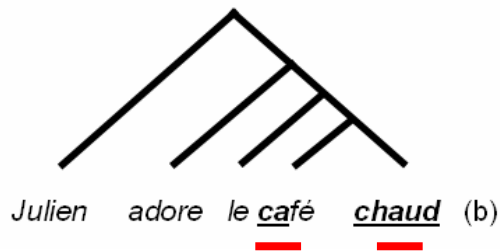
Julien   adore   le café   chaud (b)

Stress clash, since the 2 units with successive stressed syllables *café* and *chaud* are dominated by the same node in the syntactic structure. The clash provokes a shift to the left of the first stress, which is placed on the first syllable of *café*.

The emphatic stress is usually located on the first syllable of the element emphasized. If the number of syllables is sufficient, it can coexist with the lexical stress of the same element. In *extraordinairement sympathique*, emphasis on the first syllable of *extraordinairement* and lexical stress on the last syllable of *sympathique* leaves a sequence of 7 unstressed syllables. To avoid this long sequence of unstressed syllables, a lexical stress will be placed on the last syllable of *extraordinairement* to result in the following stress pattern:

extraordinairement sympathique

An adjective with less syllables like *joyeux* would not generate this condition, and no lexical stress would be obligatory on *extraordinairement*. The resulting stress pattern is then:

extraordinairement joyeux

The stress group is defined as a minimal unit of prosody containing one and only one lexical stress.

Prosodic structure

Let's now turn to amore general and possibly more interesting function of sentence intonation, namely to indicate some kind of hierarchy in the sentence. We will call this hierarchy prosodic structure, keeping our original designation (dated back in Martin, 1975), but not to be confused with the same term used in dominant (North American) phonological descriptions of intonation. In those latter approaches, prosodic structure interacts with the intonational phrase and other entities, to give account to a mixture of phonetic and phonological facts (such as rhythm, boundary effects, and so on). By contrast, the prosodic structure discussed here is the result of an hypothesis, which assumes the existence of minimal prosodic units called prosodic words, organized

hierarchically in a prosodic structure. The number of levels on this structure is not a priori limited.

Once rules to define prosodic words (stress groups) have been established, we examine the assumed hierarchical grouping of these words. If such a prosodic structure does exist, we can consider various relationships with other structures organizing the sentence, such as the syntactic structure. A priori, we can envision two extremes governing this relationship:

1. the prosodic structure (PS) and the syntactic structure (SS) are totally independent
2. the prosodic structure (PS) is congruent with the syntactic structure (SS)

A third possibility where both structures would be identical is of course excluded, as prosodic and syntactic units do not correspond necessarily to each other.

As we assumed the existence of a prosodic structure, there must be, according to this assumption, prosodic markers that do indicate this structure. Of course, if we want to discover how these markers function, we have to ensure that the examples studied will indeed realize those intended structures. The second assumption above, making both prosodic and syntactic structures congruent would be handy for this purpose, but unfortunately, it is easy to find counter-examples where prosody is not congruent to syntax. Are then both structures totally independent?

In order to see a bit more light in this, we could examine some special cases of sentences, in which the syntactic structure is either ill defined (i.e. ambiguous) or even absent. Three classes of example come to mind:

1. telephone numbers
2. table of multiplication
3. syntactically ambiguous sentences

Examples belonging to these classes are of course pronounced with a specific structure, which can reflect either the graphic organization of data (e.g. telephone numbers), the arithmetical organization of operation (e.g. table of multiplication). The third category may be more problematic to observe, as to be truly ambiguous, these sentences must appear in a vacuum, without neither context nor situation. Nevertheless, careful experimentation may force speakers to use prosodic structure to ensure the disambiguation of these sentences. To these three classes, we could add, being even more cautious, the class of read sentences.

4. read sentences

To have a reasonable trust into the assumed prosodic structure of read sentences, the assumption here relies of the style of reading, possibly acquired at school at an early age, and whose goal is precisely to have the reader match the prosody with the syntactic organization of the sentence.

Using these four classes of specific relationship between prosody and syntax, we can then proceed by expansion, starting with the simplest PS with one prosodic word, to the more complex, considering all possible combinatorial configurations. The simplest prosodic structure has only one prosodic word, and there is of course only one way to organize this unique word into a structure. The melodic contour located on the stressed syllable has no role in indicating anything in the structure, and is used to mark the modality, as discussed above. Let's call this contour Cd if the sentence is declarative, and Ci if interrogative. As we already know, Cd (Ci) is in final position, on the last stressed syllable of the propos.

When the prosodic structure contains two prosodic words, two configurations are possible (from now we will consider only declarative modality to simplify the discussion). The first with no *thème* (the *propos* covers the whole sentence), the second with a division into *propos* and *thème*, as seen earlier.

In the latter case, the declarative modality contour ends the propos, whereas the thème has a final redundant declarative contour, noted C(d). Phonetically, C(d) is realized frequently by a flat melodic contour. Now if no division propos-thème occurs, the first prosodic word has a stressed syllable with a contour, which we can characterize by negative properties: it has to be different from Cd and Ci. Let's call this contour C1. Turning to experimentation, we can observe indeed that the melodic variation is flat, slightly falling, or occasionally rising, depending on the speaker.
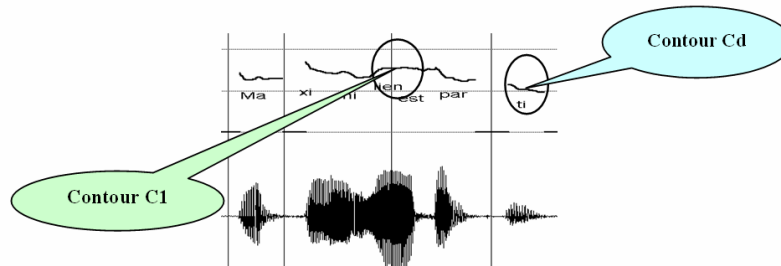

Figure 5: Fundamental frequency curve of a declarative 2 prosodic word structure

Again these variations are predicted by the deductive approach. As only one structure can organize two prosodic words, the function of C1 if neutralized in this respect and the contour can phonetically by anything, as long as it is different from Cd and Ci.

Things become more interesting with prosodic structures with three prosodic words. Let's call these words A, B and C. Combinatorial analysis tells us that these 3 words can be organized in 4 distinct hierarchies:
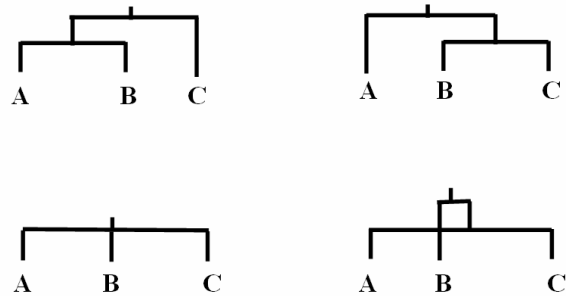
Here again we would need another constraint, not discussed in details here, stating that all prosodic structure must be planar. We then exclude configurations like [A [B] C] where A and C form a group AC and then form the complete prosodic sentence [A B C] (case of *incises* in French).

    If the prosodic structure exists, we should be able to discover the mechanism of its indication, looking at the melodic contours on the prosodic words stressed syllables, as long as we are reasonably certain that the analyzed sentences are pronounced with those intended structures. In order to do that, we can use telephone numbers, table of multiplication, syntactically ambiguous sentences, or just read sentences. After this prosodic grammar will have been discovered, we can then turn to other style of speech such as spontaneous, and determine then better the relationship between syntactic and prosodic structures. Otherwise, looking directly to spontaneous speech to analyze the prosodic grammar will bring us almost certainly to failure.

To ensure proper stressing of stressable syllables, we will consider examples with relatively long prosodic words. Below each prosodic word, the prosodic grouping is indicated with square brackets.

L'hippopotame de Nabuchodonosor est très contrarié   *structure [[AB] C]*

$C(2)$ $C1$ Cd

The contour C1 discovered above is now located on the last prosodic word of the first group [AB], and another contour, called C2, appears on the first prosodic word. Phonetically, C1 is now manifested by a rising contour, with no falling or flat variants. C2 on the other hand is manifested by a flat or falling contour. Again, this contour is neutralized, as it has only to be differentiated from all other contours that can appear in its place, i.e. Cd, Ci and C1. It is therefore noted C(2).
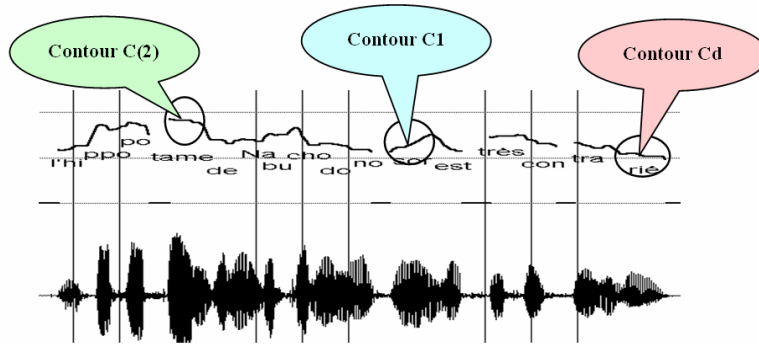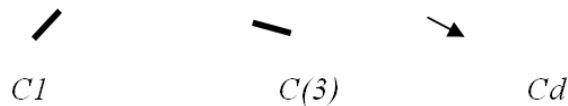
Figure 6: Fundamental frequency curve of prosodic structure **[[AB] C]**

L'hippopotame avait pu contrarier Nabuchodonosor   *structure [A [BC]]*

C1   *C(3)*   *Cd*

C1 is on the first prosodic word, and the contour on B is called C3. Phonetically, C1 is rising, and C3, being neutralized, is flat or slightly falling.
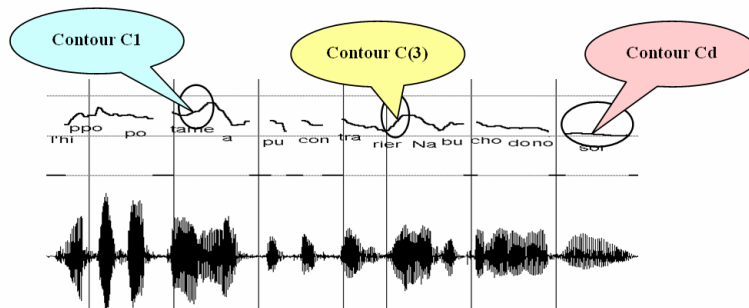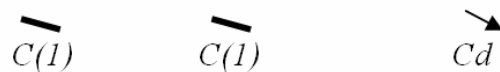

Figure 7: Fundamental frequency curve of prosodic structure **[A [BC]]**

L'hippopotame, l'hippocampe, l'hippocéphale   *structure [A B C], enumeration*

C(1)   *C(1)*   *Cd*

C1 appears of the two first prosodic words, and is neutralized in indicating the grouping of the 3 prosodic words, since they are at the same level in the hierarchy.
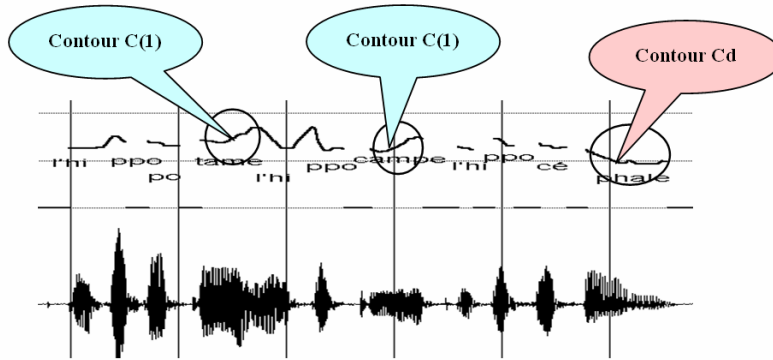
Figure 8: Fundamental frequency curve of prosodic structure **[A B C]**

The same process can be extended to more than 3 prosodic words. Structures organizing 4 prosodic words (again excluding any propos-thème division) would lead to 11 planar configurations (Martin, 1982). For example, the [AB][CD] structure would generate a sequence of contours C(2) C1 C(3) Cd, with the first and the third contours neutralized. When those contours are not neutralized, they reveal the grammar of prosody used in French. This grammar operates with 2 rules:

1. A contrast of slope rule to the right (in any node, the slope of a contour is inverse of the slope of the contour of the immediately dominant node)
2. A contrast of amplitude of melodic variation (any sequence of consecutive same slope contour dominated by distinct nodes contrast with their amplitude of melodic variation).
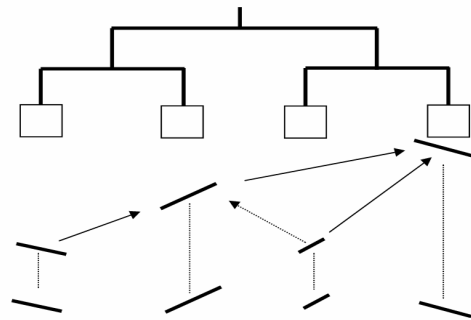
The resulting sequence of contours is then C(2), C1, C(3) and Cd. An example of fundamental frequency variation corresponding to this structure is given in fig. 16. The text is ***l'hippopotame d'Antonio a pu contrarier Nabuchodonosor***.
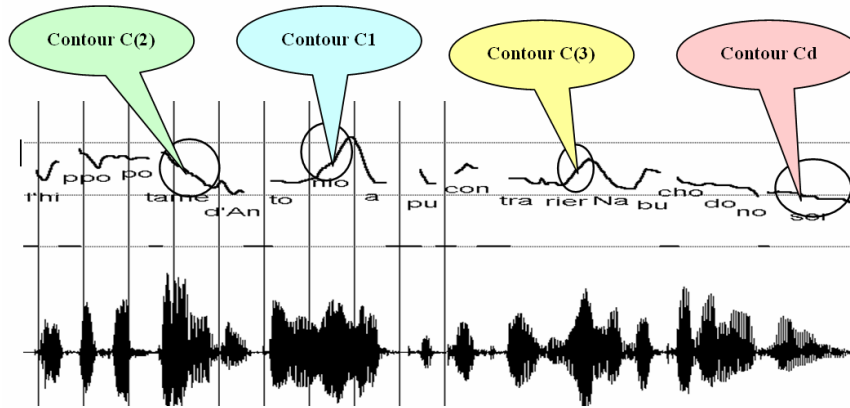
Figure 9: Fundamental frequency curve of prosodic structure **[A B] [C D]**

Using the features Rising, Ample (referring to the amplitude of melodic variation), and Long (referring to contour duration), the phonological description of these contours appears in the following table:

	C2	C1	C3	Cd
Rising	-	+	+	-
Ample	-	+	-	(-)

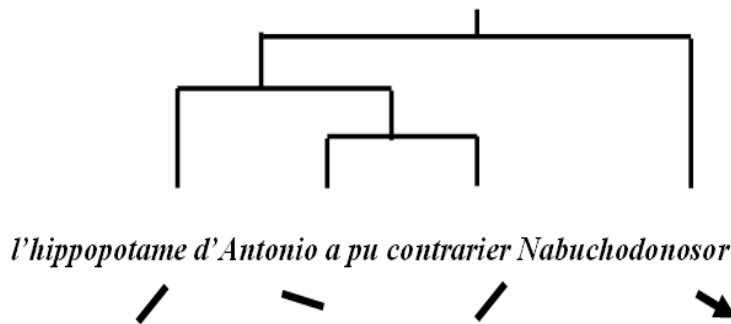## Association between syntax and prosody

The grammar of intonation has been discovered by assuming congruence between syntax and intonation. Prosodic words are defined from the effectively stressed syllables, and the hierarchical organization of the prosodic words is supposed to match the syntactic hierarchy of the corresponding units. The question now is to determine if congruence is the only possible association mode possible between the two structures.
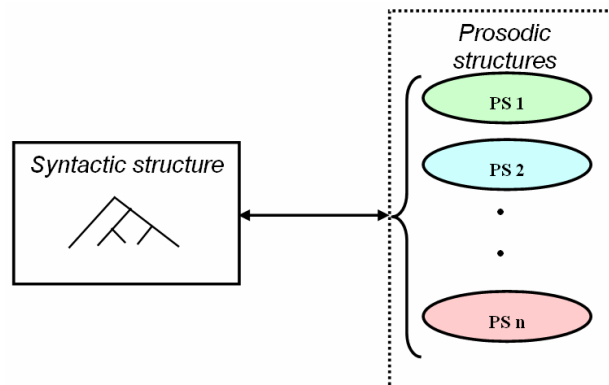
To find out, we could observe a large number of prosodic structures in spontaneous speech, and possibly establish statistics of all observed prosodic structures. This will be discussed in the next lesson.

Syntactic clash condition: if A, B, C and D are consecutive prosodic words, the prosodic grouping A [B C] D is not allowed if syntax form groups such as (A B) (C D). The prosodic structure cannot group prosodic words whose corresponding syntactic units are dominated by distinct nodes.

An example of syntactic clash in a structure with four prosodic words would be

l'hippopotame d'Antonio a pu contrarier Nabuchodonosor

Once the conditions of impossible association between the prosodic and the syntactic structure have been established, it remains to see if some structures are more used than others, and why. The condition of **eurythmicity** gives some light into this, according to two principles that complement each other:

1. among all possible prosodic structures that can be associated with a given syntactic structure, the most eurhythmic will be used more often;
2. if a non eurhythmic prosodic structure is used, there will be a rhythmic compensation of prosodic groups of large difference in their number of syllables (Wiolland, 1985).

To illustrate this two faces conditions, consider the following sequence. The congruent solution causes prosodic groups of the first level in the structure to contain respectively

[Le père de Max] [est parti]	4 + 3
[Le grand père de Max] [est parti]	5 + 3
[L'arrière grand-père de Max] [est parti]	6 + 3
[L'arrière-arrière grand-père de Max] [est parti]	8 + 3

Rhythmically, very unbalanced sentences such as the last one will be pronounced with a faster speech rate on the first group ***L'arrière-arrière grand-père de Max***, and a slowest speech rate on the last group ***est parti***, in order to compensate for the large difference in the number of syllables of both prosodic groups (8 vs. 3)

If the speaker retains the eurhythmic solution, the resulting prosodic structure could be

[Le père de Max] [est parti]	4 + 3
[Le grand père] [de Max est parti]	3 + 5
[L'arrière grand-père] [de Max est parti]	4 + 5
[L'arrière-arrière grand-père] [de Max est parti]	6 + 5

The next lesson will discuss the extension of this model to spontaneous speech, by examining the relation between islands of prosody and units of macro syntax.

References

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