E. ON FRENCH PROSODY

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This report describes the organization of the fundamental frequency (F_0) variations in French sentences. Interpretation of F_0 contours in French is quite different from the interpretation of F_0 variations in English. Stress plays an important role in English, whereas in French each syllable of a multisyllabic word pronounced without emphasis receives almost the same amount of stress.[1] But phoneticians also feel that there is a somewhat stronger stress on the last sounded syllable of words pronounced in isolation and on the last sounded syllable of the sense groups embedded in a sentence.[1,2] As Delattre[2] noticed, neither intensity nor F_0 are consistent correlates of this final stress ("accent final"): "... les variations d'intensité ne sont pas proéminentes dans l'accent, mais partout plutôt effacées"[3] and furthermore: "Il faut donc admettre que le rôle de la hauteur, si important qu'il soit comme facteur de l'accent, reste accessoire."[3] Only duration is generally recognized as a consistent correlate of the final stress: "La durée est le seul des trois éléments acoustiques qui soit toujours, par sa proéminence, un facteur de l'accent."[4]

This study is based on the analysis of the F_0 patterns of declarative sentences read by six native speakers of French (three males and three females). It does not concern spontaneous speech. Signals from an accelerometer attached to the throat and from a conventional microphone were recorded using a two-channel tape recorder. F_0 contours were detected from the accelerometer waveform using a computer program (written by Shinji Maeda) and were displayed with envelopes of the corresponding speech signal on an oscilloscope. The reading material includes a paragraph and isolated sentences (listed in the appendix). The selection of the material was influenced by the previous results[5] of a systematic analysis of the F_0 patterns for one professional speaker.

1. Use of F_0 Contours to Demarcate Constituents within a Sentence

What is the role of F_0 variations within sentences read by native speakers of French in a nonemphatic manner? In French, as in English, intonation is related to the grammatical organization of the sentences. (The relationship between intonation and syntax was observed quite early for English,[6] and some aspects of this relationship have been studied for French.[5,7-9]) The hypothesis within which our data are interpreted is that F_0 variations have essentially a demarcative function: along with pauses and the longer duration of the final syllable F_0 patterns mark the boundaries of the constituents of the sentence, and they generate the acoustic image of a simplified prosodic-syntactic tree structure. The prosodic-syntactic structure has, essentially, three levels: the first level is the sentence, the second is the sense group (or phrase) and the third is the word

a. Sentence Level

Figure XVI-21 is the schema of the common code used by the seven speakers (1+6) for demarcating the boundaries between sentences: a sharp fall in F_0 before a pause indicates the end of a sense group in final position in a sentence; a rise followed by a

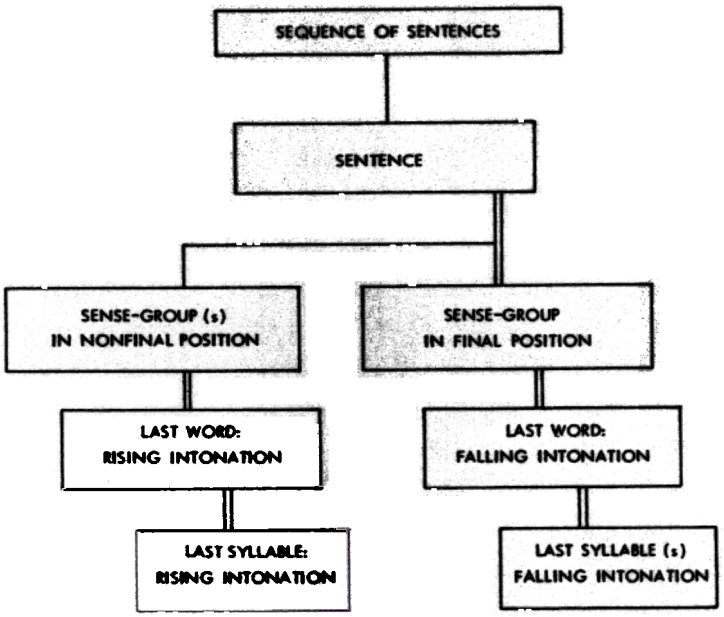


Fig. XVI-21 Schematic representation of strategy used for producing F_0 contours before pauses in nonfinal position and in sentence-final position.

pause indicates the end of a sense group in a nonfinal position in the sentence. In our analysis we have found only one exception: F_0 falls at the end of the major boundary in the fourth sentence of the paragraph (see the appendix) in the reading of one speaker.

b. Sense Group Level

The position of the sense group (final or nonfinal position) in a sentence not only determines the intonation of the last syllable of the group (falling or rising) but also influences the overall F_0 pattern for the whole group. Figure XVI-22 illustrates typical F_0 patterns for nonfinal phrases (NFP) and for final phrase (FP). Schematized contours for each phrase are indicated by dashed lines sketched above the actual contours. Figure XVI-22a and 22b represents contours for phrases composed of only one lexical word, in nonfinal and final position in a sentence, respectively (sentences 19a and 19b in the appendix). Figure XVI-22c and 22d displays the contours of the last two phrases

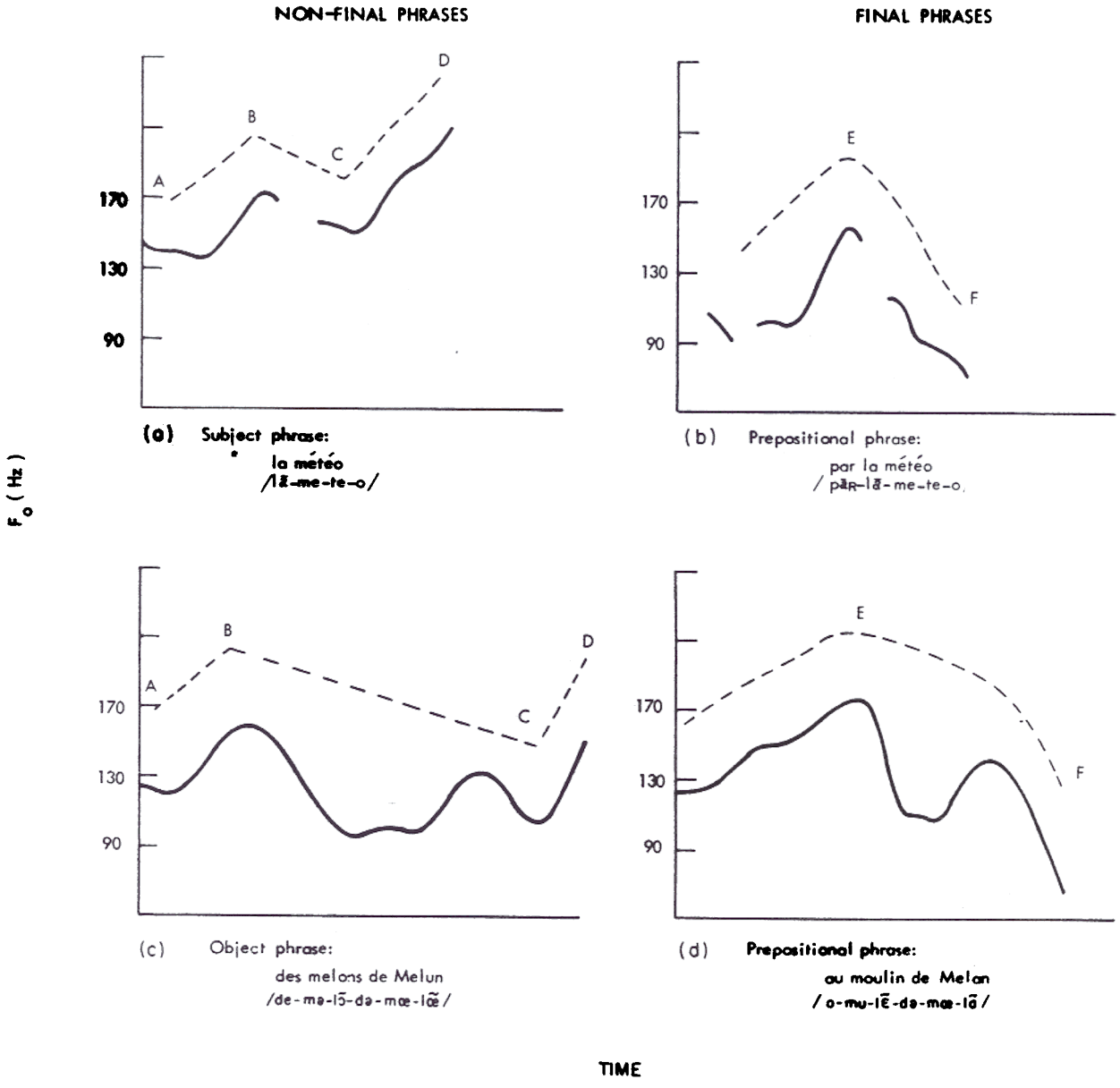


Fig. XVI-22. Typical F_o patterns for nonfinal phrases and for final phrases. Dashed lines are schematized representations of the contours in which local segmental influences have been ignored.

in the same sentence (sentence 5a in the appendix): the object phrase "des melons de Melun," and the prepositional phrase "au moulin de Melun." (Notice that the two content words of each sense group have the same semantic relationship.)

The F_0 pattern for a NFP is characterized primarily by a rise on its last syllable (segment CD on the schematized contours in Fig. XVI-22). An F_0 rise (segment AB) occurs at the beginning of the group, generally from the beginning (first syllable) of the first lexical word. (A smaller rise can be observed sometimes during the preceding function word, particularly at the beginning of a sentence.) F_0 reaches its higher value (point B) during the first lexical word of the group. The only exception that we found in our analysis was for the NFP "Grâce à ces associations avec les universités voisines ..." (Thanks to its associations ...): the maximum F_0 value was found on the word "grâce" (4 speakers) and also on the word "associations" (2 speakers). Then the overall F_0 contours for the whole group (segment BC) gradually fall until the final rise on the last syllable. Rising intonation (segment CD) creates an impression of stress on that syllable. For example, in Fig. XVI-22c the syllable "lun" in the word "Melun" is perceived as stressed. This final stress at the end of the group generally masked partially or completely the potential stress on the last syllable of every lexical word inside the group.

The F_0 pattern for an FP is quite different. This pattern is characterized primarily by a fall of F_0 from the beginning or near the beginning of the last lexical word in the sentence, if the last sense group is only one lexical word (preceded or not by function words). The fall is indicated by the segment EF on the schematized contour in Fig. XVI-22b. On the other hand, this fall (segment E'F' in Fig. XVI-22d) starts from the last syllable of the penultimate lexical word in the sentence if the last sense group is composed of more than one lexical word. (When FP is a monosyllabic content word preceded by function words, the maximum F_0 value generally occurs during the function words.) If the last lexical word of the group is a long word (more than 3 syllables, for example), the maximum F_0 value can be found either on the last or on the penultimate word: the F_0 maximum occurs on the syllable "tut" of the FP "... de l'institut de technologie" (sixth sentence of the paragraph) for three speakers, on the syllable "tech" for two speakers, and on the syllable "no" for another speaker. The lowest F_0 of the whole sentence is reached during the last syllable: F_0 not only falls close to the extreme lower limit of the speaking voice, but also the intensity level becomes so low that, as Coustenoble and Armstrong noticed,[1] it is difficult for a foreigner to hear it. This last syllable in the group is not perceived as stressed and the rule of stressing the last syllable of a sense group is not applicable at the end of a sentence. The perception of stress is shifted to the syllable in the group which has higher pitch. Using synthetic speech, Rigault[10] has shown that pitch is more effective than duration and intensity in producing the impression of stress for a French listener.

c. Word Level

Figure XVI-23 illustrates the next division, the division of the sense group into successive words. This figure displays the F_0 pattern of a subject noun phrase (sentence 18a in the appendix), composed of three lexical words: "Un retour offensif de l'hiver ...". It can be observed in Fig. XVI-23 that the beginning of each lexical word is characterized

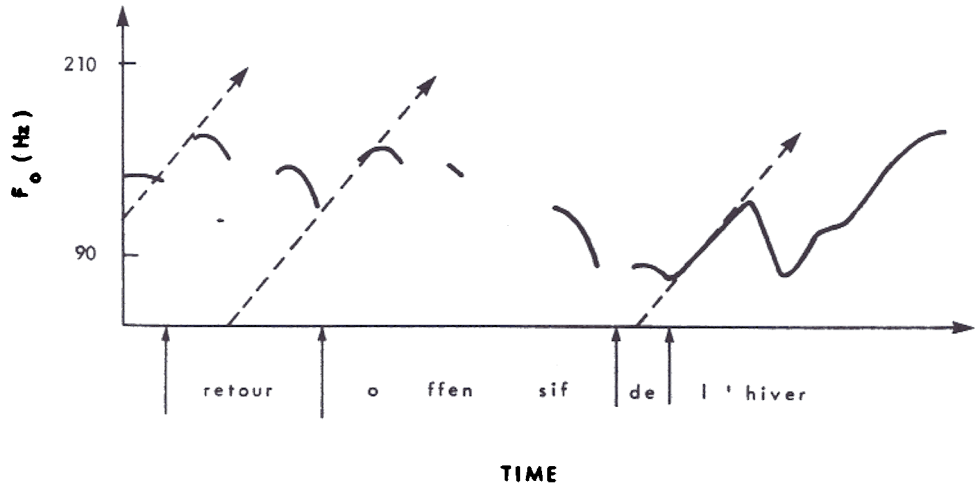


Fig. XVI-23. Use of the F_0 contour to divide a sense group into words. Dashed lines indicate initial rise associated with each lexical word.

by an F_0 rise. (The initial rises are indicated by dashed lines.) An initial rise may not occur for some words in the sentences, especially for those words that the speaker does not consider important. For example, when a lexical word is repeated twice in the sentence (such as the word "sciences" in the first sentence of the paragraph, and the word "consonnes" in sentence 21), the rise can be omitted in the second repetition of the word (three speakers omit the rise in the second word "consonnes"). Figure XVI-24 illustrates one of the cases in the NFP "... des consonnes initiales, des consonnes finales, ...". It may also happen that two successive lexical words are pronounced with the F_0 pattern of one single word; the regrouping of the words has a tendency to shorten the total duration of the words. Regroupings are most likely to happen in rapid speech. Figure XVI-25 illustrates the F_0 patterns found for the same NFP as in Fig. XVI-24. The speaker was asked to repeat the sentence more rapidly. In fact, the durations of the segments are almost unchanged, but the change in the F_0 pattern creates the impression of more rapid speech. Initial rises are more or less important, depending on the speaker and the speed of elocution, but we noticed the same tendencies for all speakers:

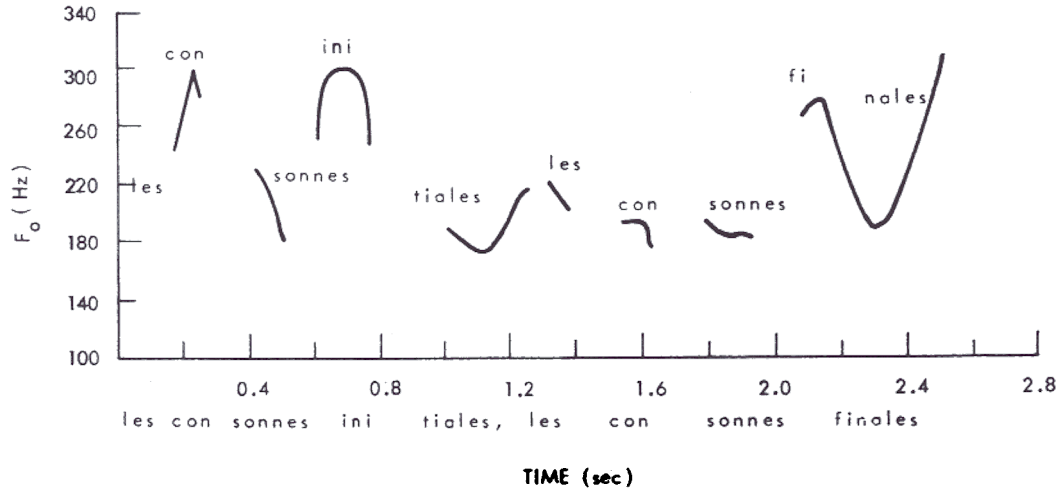


Fig. XVI-24. Lack of an initial F_o rise when a word ("consonnes") is repeated in a sentence.

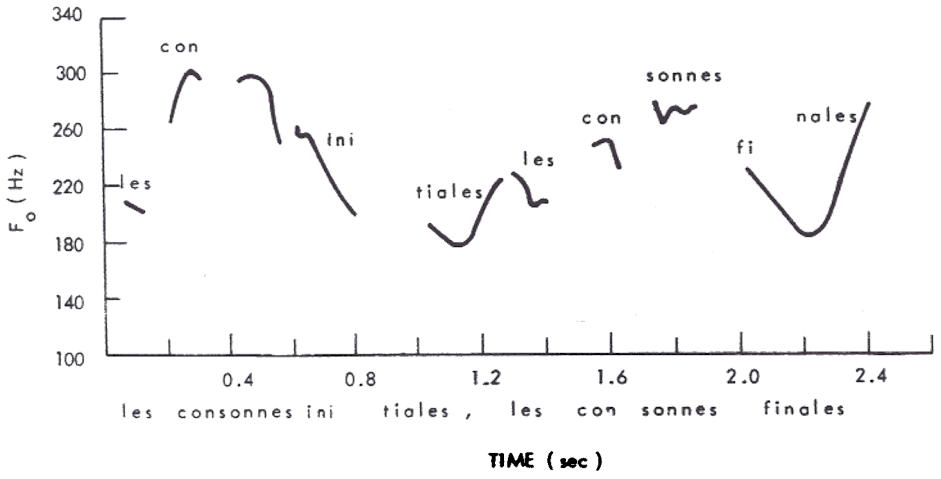


Fig. XVI-25. Pronunciation of a group of more than one word with the F_o pattern of a single word, giving the impression of more rapid speech.

(i) The initial rise on the first lexical word of the group is larger than initial rises on the following words.

(ii) Longer words (more than 2 syllables) have an initial rise more consistently than shorter words. (Three speakers suppress the initial rise in two-syllable words with rising intonation.)

(iii) The initial rise appears more clearly after function words than after another lexical word, and more clearly after a lexical word with falling intonation than after a

lexical word with rising intonation.

What is remarkable in the organization of the F_0 variations is not only the demarcative function of the F_0 patterns but also the subordination of each constituent to the one immediately above it. This fact is probably due to physiological constraints, as suggested by S. Maeda in Section XVI-D. The F_0 pattern for a shorter constituent is often shifted to the pattern of the immediately higher level constituent. For example, a short sentence (composed, say, of three or four lexical words and less than eight syllables) is equivalent to a sense group in final position in a longer sentence. The pattern for a sense group formed by two or three lexical words containing less than approximately five syllables is acoustically equivalent to the pattern of a single word. The boundaries between the successive words in the sense group cannot be seen from the F_0 pattern (such as in the NFP "les sciences de l'ingénieur" pronounced by all six speakers). Rapid speech produces the same effect: the constituents of the lower level (words) are less clearly demarcated, and the pause between two sense groups may be suppressed.

2. Interspeaker Differences in Actualization of F_0 Contours

All seven speakers in our experiment use F_0 patterns for demarcating the constituents of the sentences, but the actual F_0 contours differ from one speaker to another, and the differences are more marked for some speakers than for others. These differences are not only ascribed to anatonomical differences of individual speakers but also to an individual manner of the actualization of the demarcative features. We have found two kinds of major difference for F_0 patterns given by different speakers for the same sentence. The first kind of difference may be acoustically perceived and, to a certain extent, interpreted as semantically relevant; the second kind concerns only individual variants in the production of the prototype F_0 pattern, corresponding probably to differences in laryngeal gestures to accomplish a contour.

a. Speaker's Interpretation of the Relation between Words

The final word in a sense group has a rising or falling intonation, depending on the position of the group in the sentence. The intonation of the words within a sense group depends more on the speaker's own judgment of the closeness of the relation between the successive words. A falling intonation indicates the close semantic relation of a word to the next word. For example, an adjective followed by a noun has a falling intonation in the patterns for each of the seven speakers. (The two words, as we have mentioned, can also be regrouped into a single prosodic word.) A rising intonation, on the other hand, indicates that the word is relatively independent of the next word. Figure XVI-26 illustrates the actual F_0 contours of the subject phrase: "L'institut de technologie du Massachusetts ..." (first sentence of the paragraph), spoken by four speakers. Informal listening to the four phrases indicates that in the first case (Fig. XVI-26a), all of the

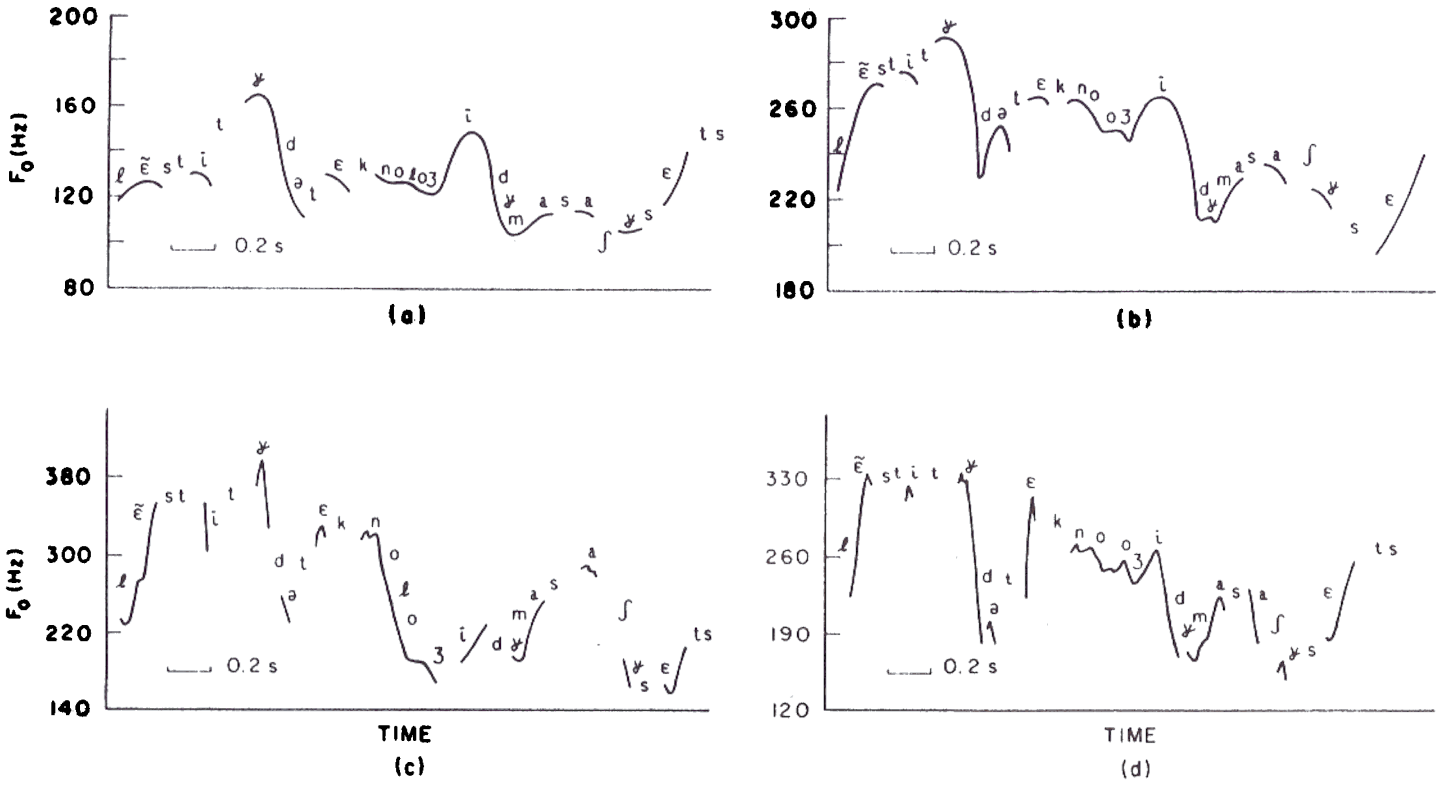


Fig. XVI-26. F_0 contours for the same phrase (l'institut de technologie du Massachusetts . . .) spoken by four talkers, illustrating different strategies for grouping the words.

words seem to be equally important. In the second case, a slightly stronger stress is perceived at the end of the group. In the third case (Fig. XVI-26c), the relation between the first two words ("L'institut de technologie") seems to be much more close than the relation between the last two words of the group ("... de technologie du Massachusetts). In the fourth case (Fig. XVI-26d), the four words seem to form only one unit, and only the last syllable of the group is heard as prominent. It is possible, by a change in the F_0 pattern, to give more information about the semantic relation between the words in sequences in a sense group. One of our speakers uses this approach in almost all sentences; the five other speakers use it occasionally. (The professional speaker used it only to disambiguate some sentences, and he gives a falling intonation to every word inside a nonfinal sense group in nonambigous sentences.) A greater degree of interspeaker variation in this respect has been found in the isolated sentences than in the text, where the context often provided enough information to specify the semantic relation between the words.

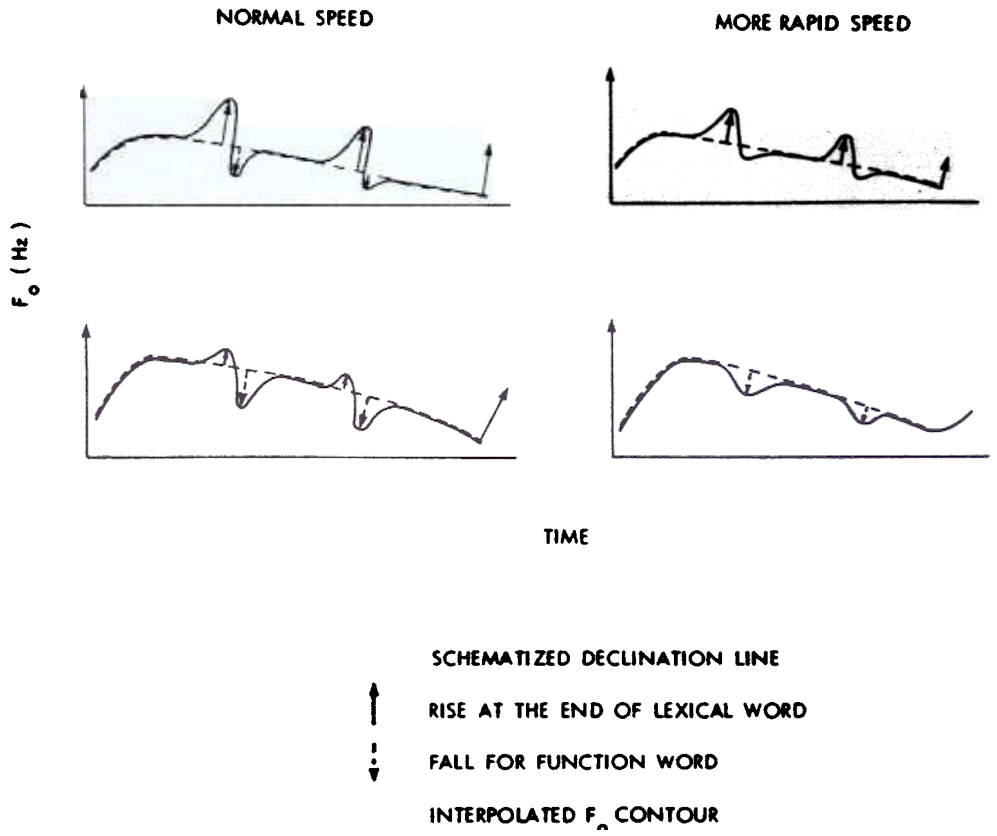


Fig. XVI-27 Schematized F_0 contours for two speakers (upper and lower) at two rates of talking, illustrating individual differences in modifying the contours in rapid speech.

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b. Individual Differences in Producing F_0 Patterns

It can be seen in Fig. XVI-26 that F_0 patterns for individual words differ greatly from one speaker to another. The differences among speakers may be due to different laryngeal gestures. Each speaker has his own characteristic pattern which he repeats in the various sentences: the similarities from one pattern to another are probably due to the same laryngeal gesture, with adjustments attributable to different phonological conditions.

Some of the components of the gesture (to increase or to decrease F_0 values) to accomplish a contour are more time-dependent for some speakers than for others. For example, when speaker 1 (Fig. XVI-26a) speaks more rapidly, the fall during function words tends to disappear, but the rise corresponding to the last syllable of the lexical word can still be easily detected visually from the F_0 contours. On the contrary, for the second speaker (Fig. XVI-26b) only the fall during the function words can be detected in rapid speech. Figure XVI-27 illustrates the two different tendencies.

Another speaker-dependent characteristic concerns the exact location of the final rise in the last syllable of a nonfinal sense group. For some speakers, the rise begins at the onset of the syllable (see one example in Fig. XVI-26a), while for others the rise starts only with the vowel (see one example in Fig. XVI-26b). Physiological data are needed before an adequate interpretation of these differences can be developed.

Appendix

Reading Material

1 Paragraph:

L'institut de technologie du Massachusetts est une institution mixte et privée, dont les centres d'intérêts principaux sont les sciences de l'ingénieur, les sciences pures et l'architecture. Il a contribué à la majorité des progrès technologiques des vingt dernières années et il continue à développer sa participation dans les techniques de pointe. La gamme des programmes de recherche est très vaste, et elle s'étend de la biologie à l'économétrie, en passant par la linguistique, l'électronique et les sciences nucléaires. Grâce à ses associations avec les universités voisines, les étudiants ont accés aux cours et aux recherches les plus variés qui soient. Le laboratoire de recherche en électronique a été construit à la fin de la seconde guerre mondiale. C'est le premier laboratoire de recherche interdépartemental de l'institut de technologie. Trois cent cinquante étudiants y conduisent des recherches, encadrés par une centaine de professeurs.

Isolated sentences:

1a – Il parle de la compatibilité entre deux êtres.
b – Il parle de l'incompatibilité entre deux êtres.
2a – Il dessine un rat d'eau au milieu de la marre.
b – Il dessine un radeau au milieu de la marre.
3a – Il dessine un chat dans un sac.
b – Il dessine un chateau sur un lac.
4a – La vie de ton ami est très intéressante.
b – L'avis de ton ami est très intéressant.
5a – J'ai acheté des melons de Melun au moulin de Melan.
b – J'ai acheté des melons de Melun au moulin.
c – J'ai acheté des melons de Melun.
d – J'ai acheté des melons.
e – Au moulin de Melan j'ai acheté des melons de Melun.
6 – La nouvelle bonne nous a annoncé une bonne nouvelle.
7 – La bonne, nouvelle victime, est bien vite repartie.
8 – La nouvelle, bonne à entendre, la réconforta.
9a – Qui va à Paris avec vous?
b – Ta cousine, Sophie, Roger, Bertrand et Raphael.
c – Ta cousine Sophie, Roger Bertrand et Raphael.
d – La cousine de Sophie Roger, Bertrand et Raphael.
10 – C'est en Espagne que j'ai vendu ma maison: j'ai vendu ma maison en Espagne.
11 – J'ai vendu la maison que j'avais en Espagne: J'ai vendu ma maison en Espagne.
12 – Le pilote ferme la porte.
13 – Le pilote, ferme, la porte.
14a – Il y a un fer à repasser dans le tiroir de la commode.
b – Il y a une robe à repasser dans le tiroir de la commode.
15 – La confédération générale du travail a organisé des manifestations et le conflit s'aggrave de jour en jour.
16 – Elle a organisé des manifestations importantes et le conflit s'aggrave.
17 – L'administration, les routes, les constructions avaient donné à cette contrée un certain essor.
18a – Un retour offensif de l'hiver est annoncé par la météo.
b – Un retour de l'hiver est annoncé par la météo.
c – L'hiver est annoncé par la météo.
19a – La météo annonce un retour offensif de l'hiver.
b – La météo annonce un retour de l'hiver.
c – La météo annonce l'hiver.

20a — Je pars en vacances.

b — Je pars en vacances cet après-midi.

c — Je pars en vacances cet après-midi à Trégastel.

21a — Nous allons parler successivement des consonnes initiales et des consonnes finales, des voyelles initiales et des voyelles finales.

b — Nous allons parler successivement des consonnes initiales et des voyelles finales, des consonnes finales et des voyelles initiales.

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